Routing and Mobility Management in the Internet of Things

Bruno Pereira dos Santos

Antonio A. F. Loureiro & Luiz F. M. Vieira
Advisors

Agenda

1. Introduction
2. Background
3. Mobility Detection
4. Routing for Static IoT
5. Routing for Mobile IoT
6. Conclusions and Future Work

1.

Introduction

- ✓ Contextualization
- ✓ Motivation & relevance
- ✓ Goals

Contextualization

- Everyday objects have been connected to the Internet
  - Wireless comm. & embedded Systems

Contextualization

- Everyday objects have been connected to the Internet
  - Wireless communication + Sensing

Contextualization

- Everyday objects have been connected to the Internet
  - Wireless communication + Sensing + Mobility

Contextualization

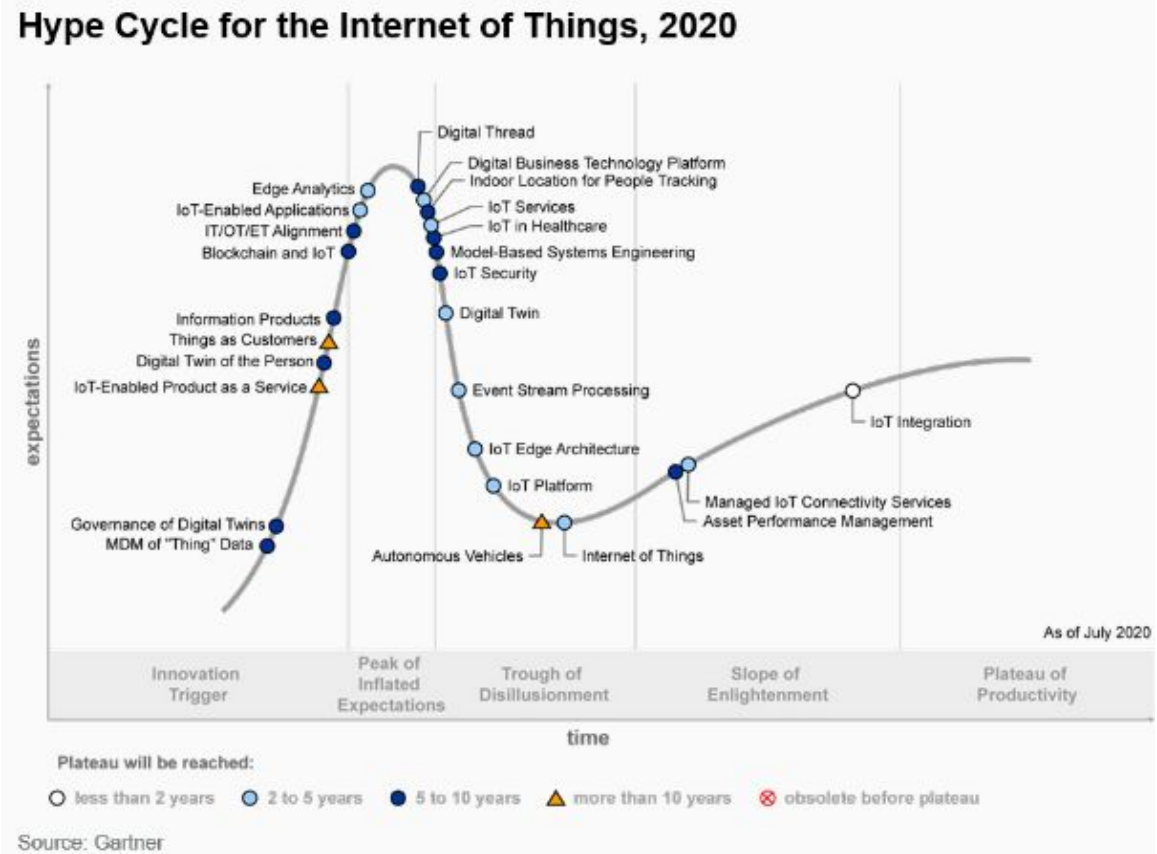
- Everyday objects have been connected to the Internet
  - Wireless communication + Sensing + Mobility

30+ Bi more in the next years.

Fonte: https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/

Contextualization

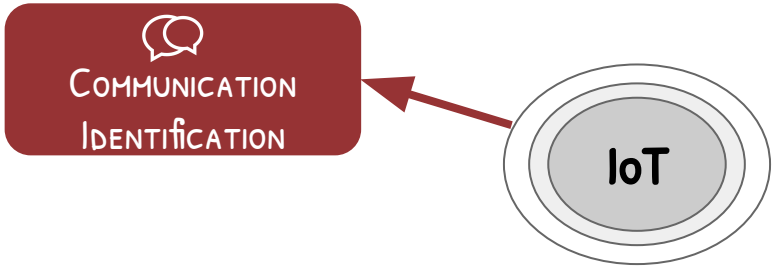
Contextualization



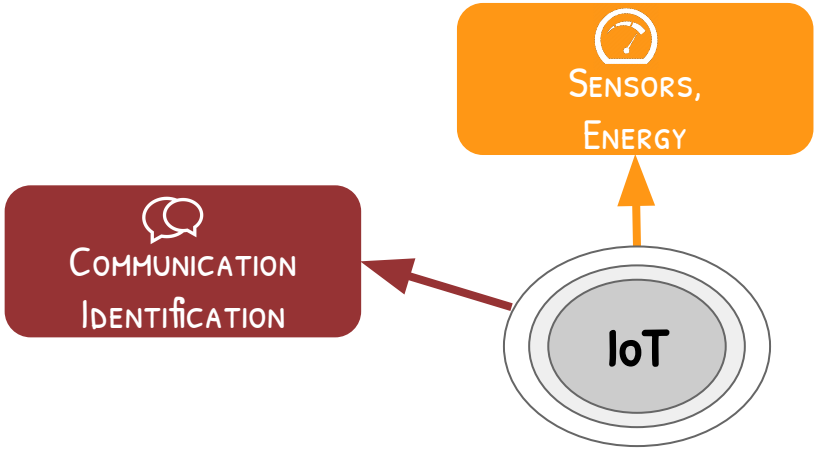
Source: Gartner

IoT is an Internet extension

Proportioning everyday objects to be connected to the Internet



IoT's basic building blocks: from technology to human value.



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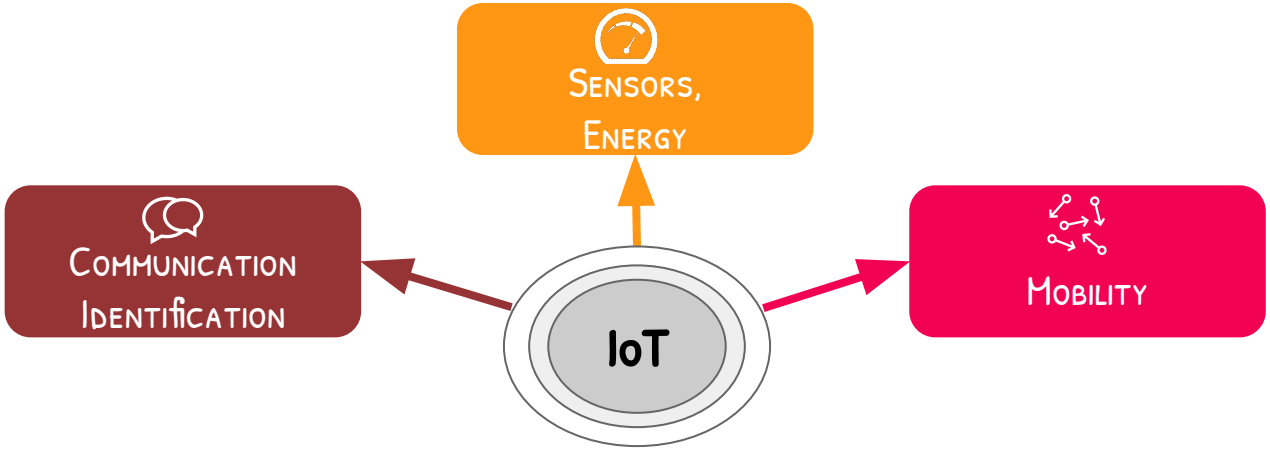

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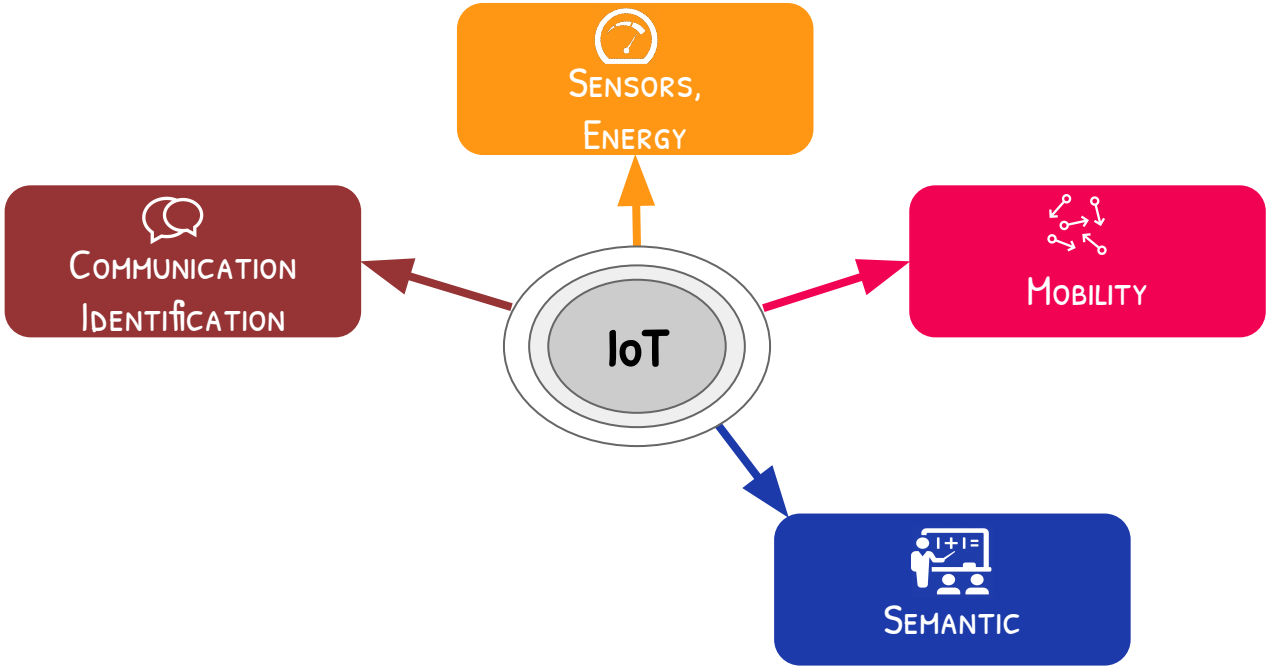

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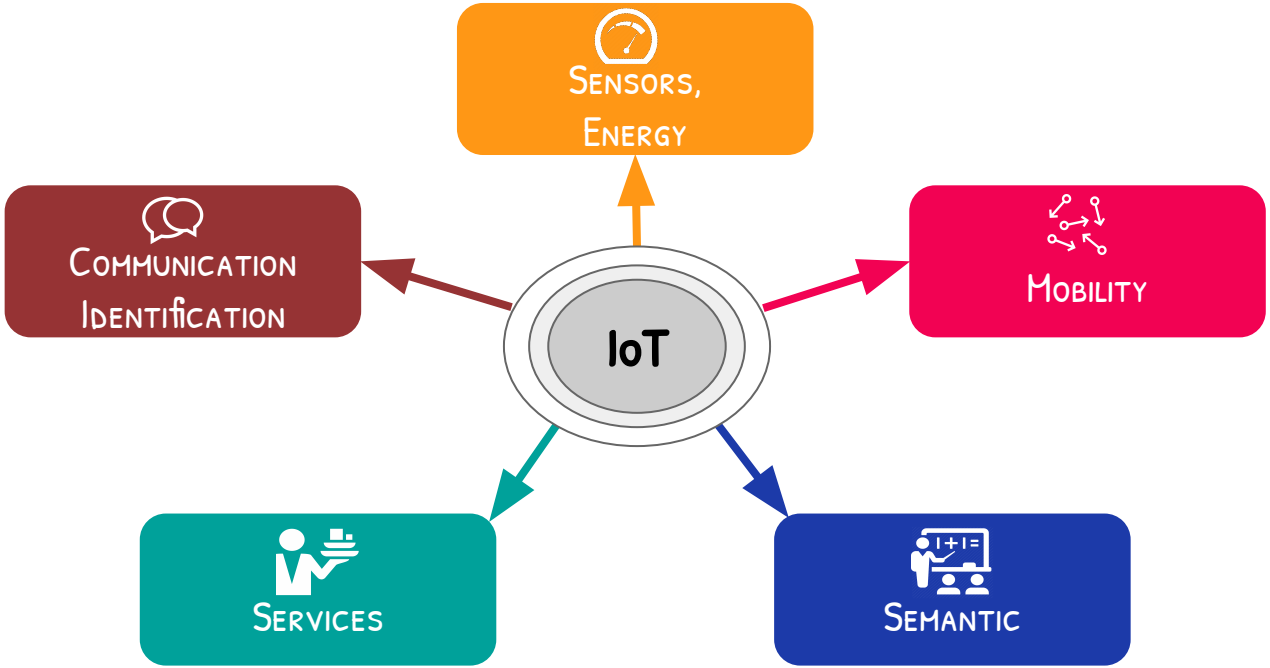

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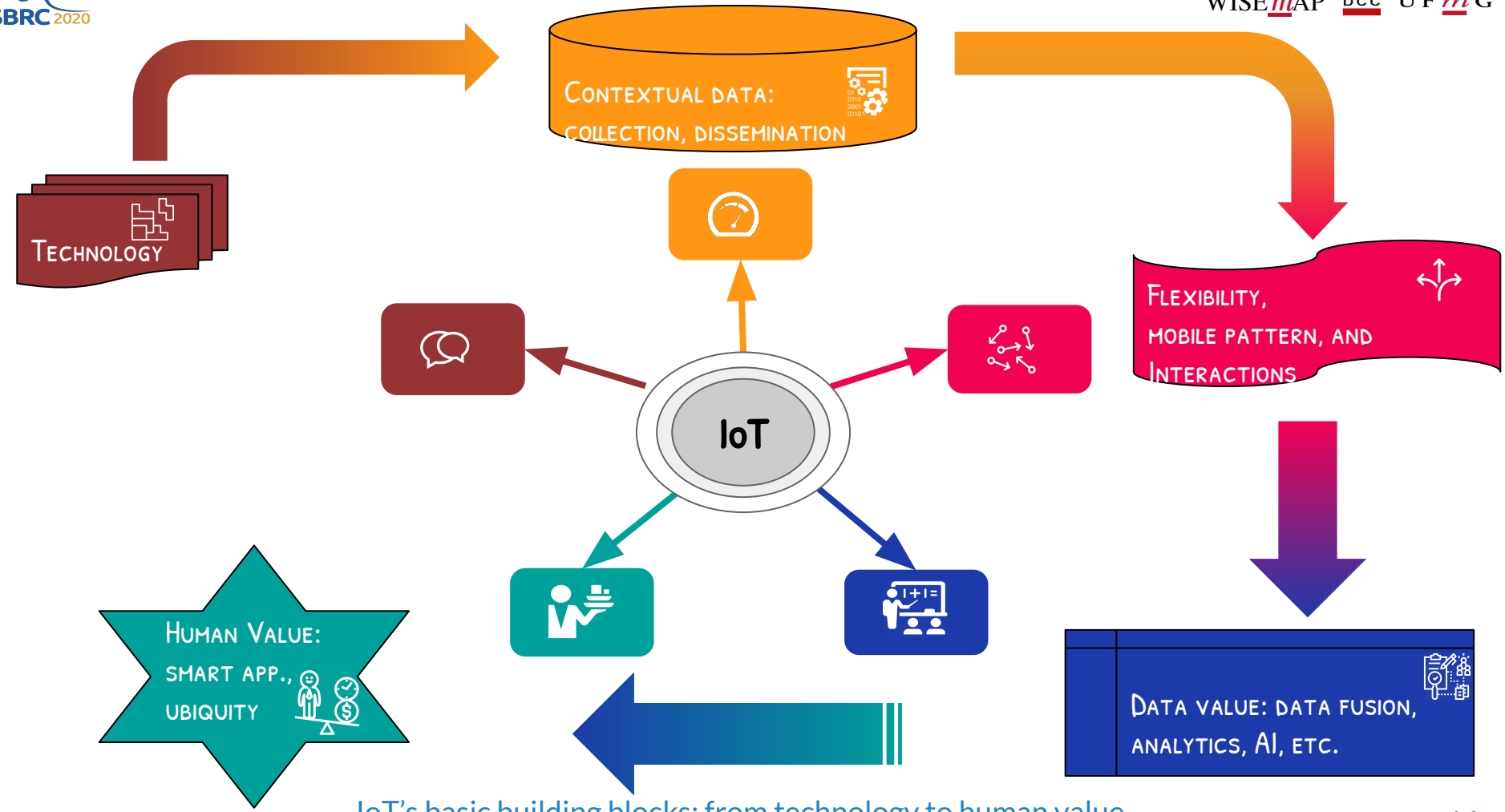


IoT's basic building blocks: from technology to human value.

Contextualization

- Smart objects play a key role in the computer network evolution
  - They have computational power
    - Communication + Sensors + Mobility
  - They are many
    - Expected 30B more devices in 2025

Contextualization

- Smart objects play a key role in the computer network evolution
- Computer network must deal with heterogeneity
  - Different capabilities, requirements, and constraints

Contextualization

- Mobility is a major factor present in everyday life
  - It makes life easier and applications more flexible
- IoT can benefit from it
  - Internet of Mobile Things (IoMT)
  - Social Internet of Things (SIoT)

Contextualization

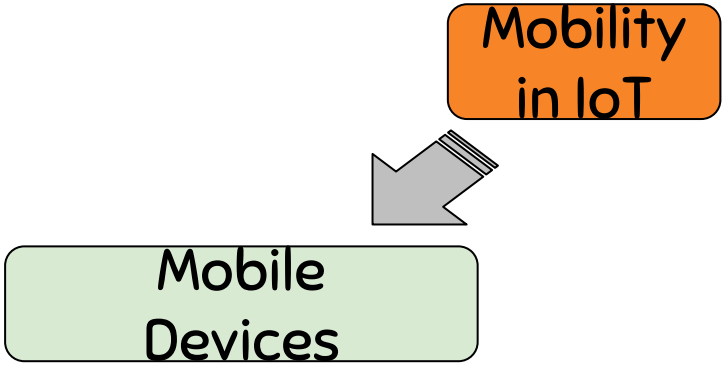
- IoT becomes more ubiquitous by handling mobility
- By supporting mobility, it is expected that:
  - Smart objects can be transported during normal usage
  - This fact does not inhibit its normal operation and communication exchanges

Motivation & Relevance

- Many solutions have been proposed to support static IoT

Motivation & Relevance

- The mobility aspect in IoT imposes several issues that need to be handled



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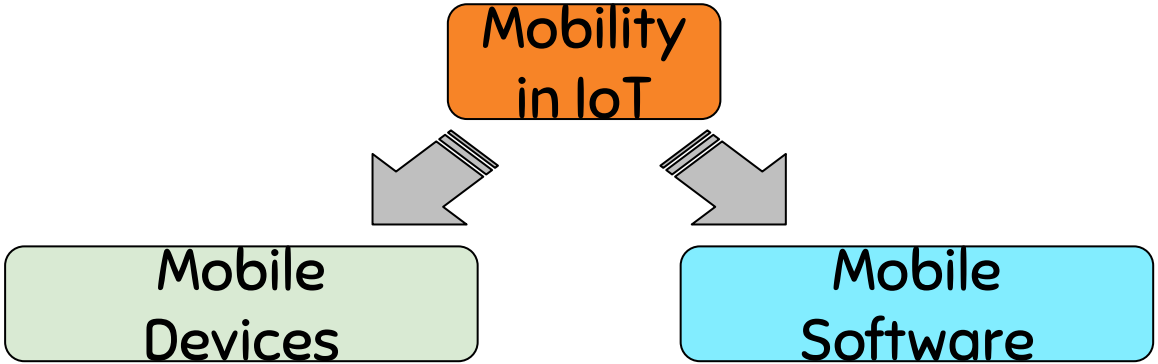

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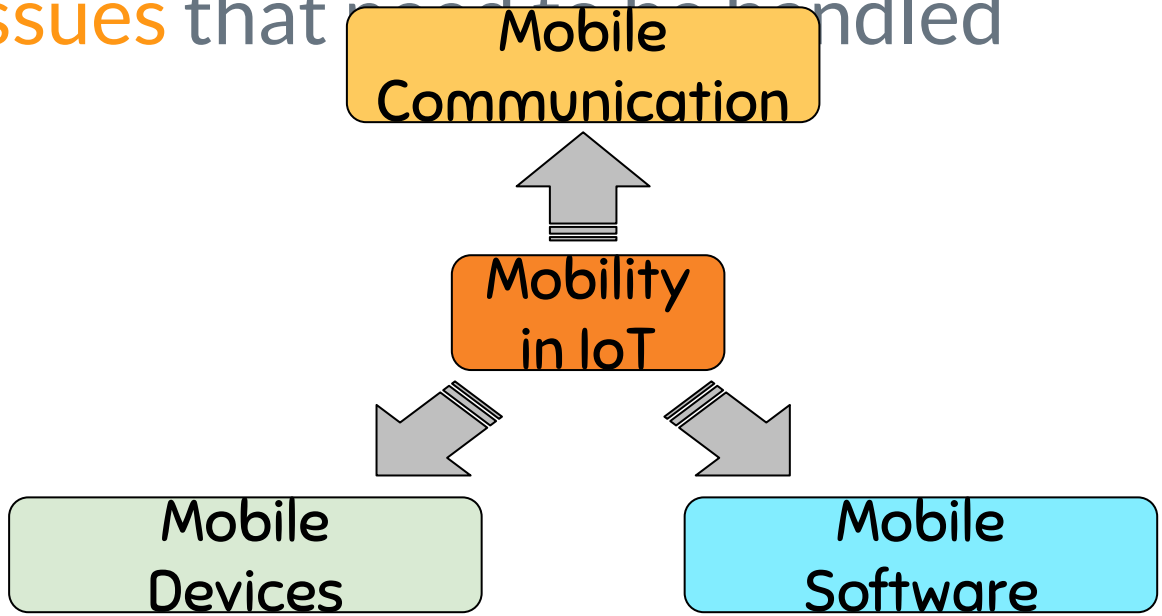
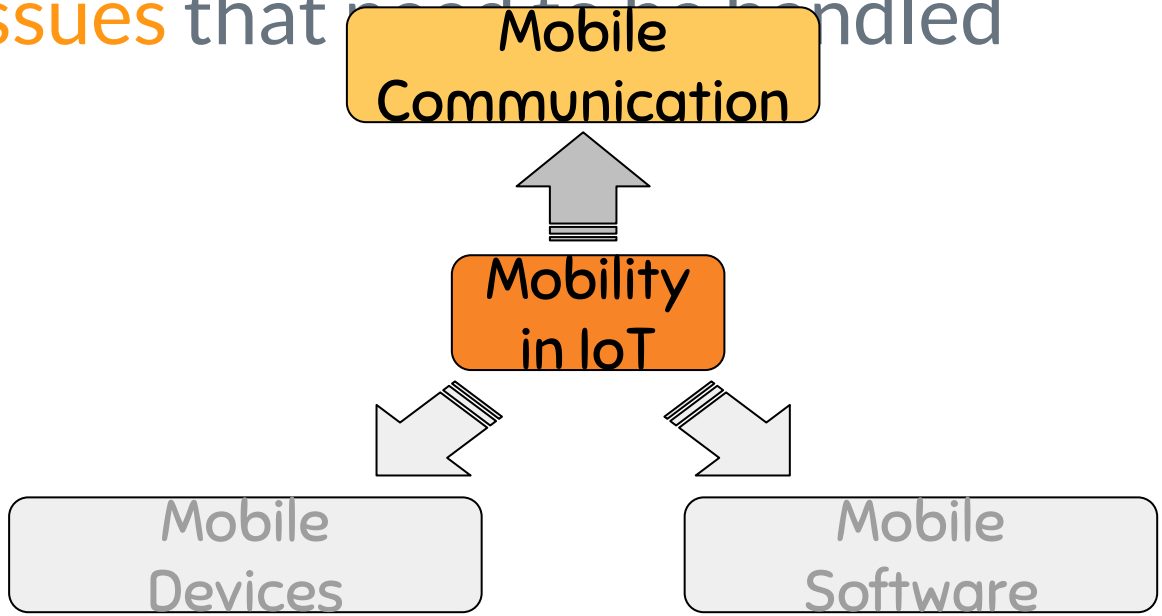


Introduction

Focus

- The mobility aspect in IoT imposes several issues that need to be handled



Goals & Scope

- To real adoption of mobile IoT's apps and performance improvements
  - IoT requires a network stack fully aware of mobility

Introduction

Goals & Scope

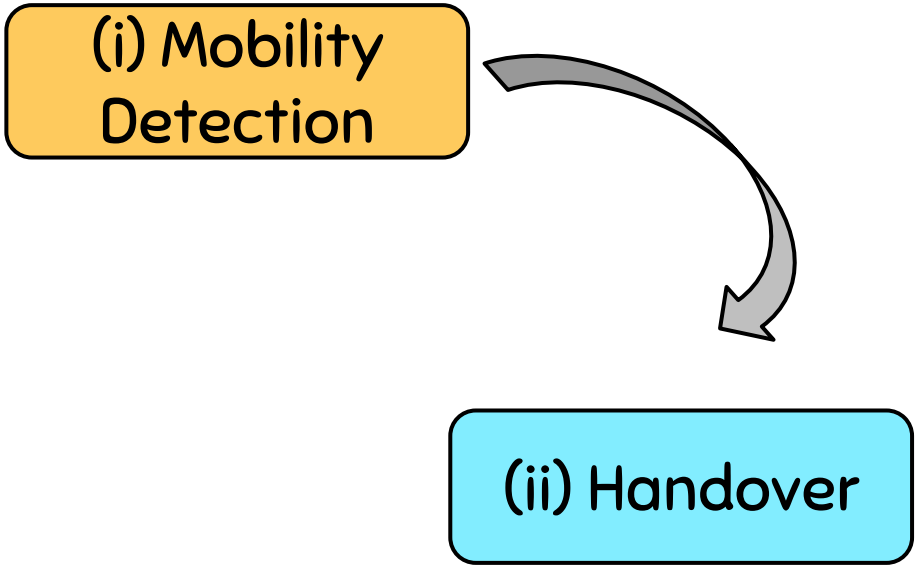
- The specific scope of is the routing layer, but we are not limited to it
- We have investigated 3 basic operations to handle mobility

Introduction

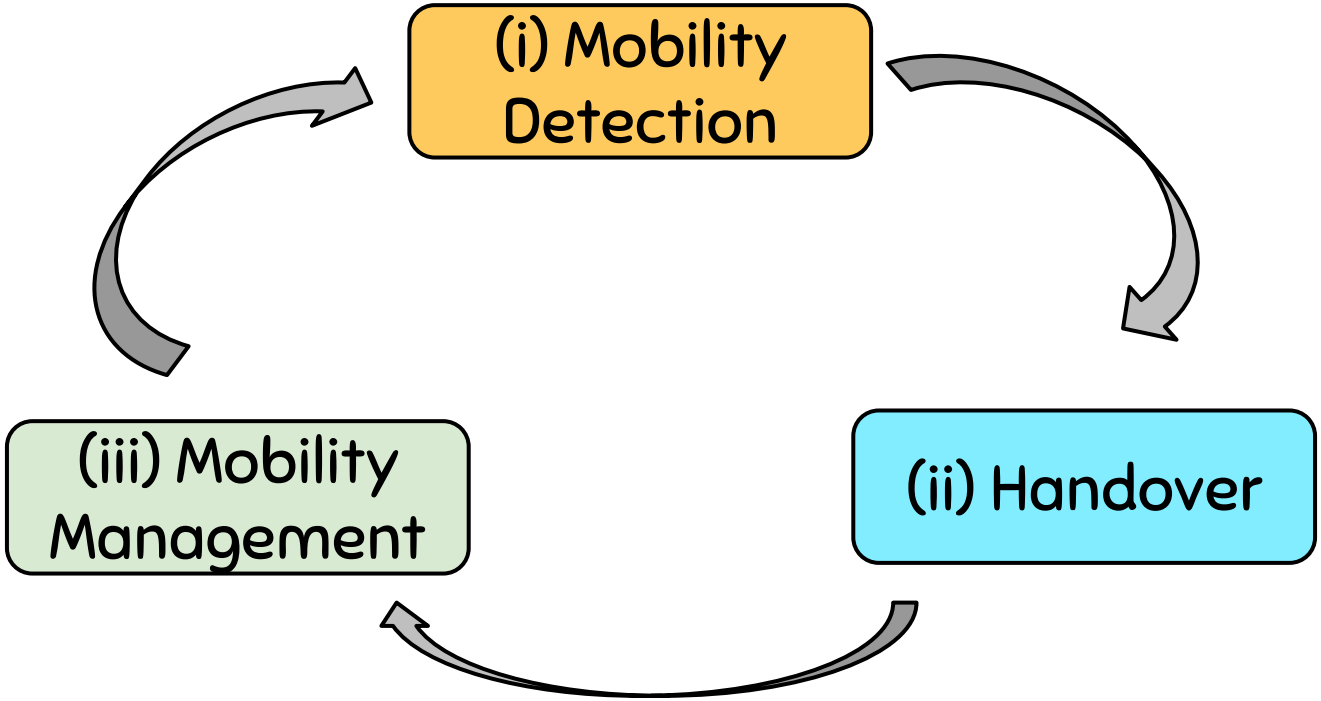
Goals & Scope

(i) Mobility Detection

Goals & Scope



Goals & Scope



Report

1. **Internet das Coisas: da teoria à prática.**
   SBRC 2016

2.

Mobility Detection: Dribble

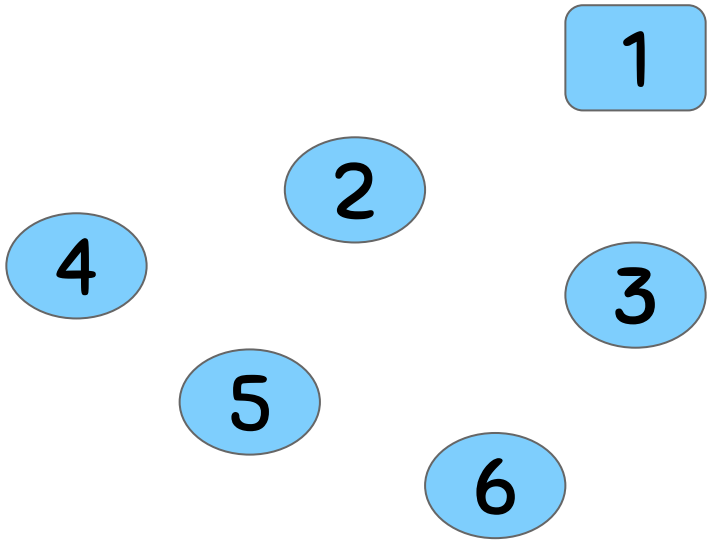
- ✓ Mobility
- ✓ Dribble design
- ✓ Reports

Mobility Detection

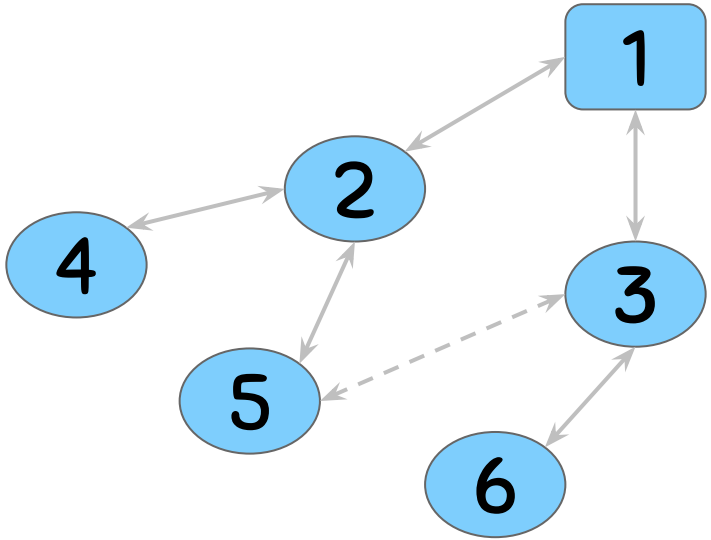
IoT routing in a nutshell

Mobility Detection

IoT routing in a nutshell



IoT routing in a nutshell



Mobility Detection

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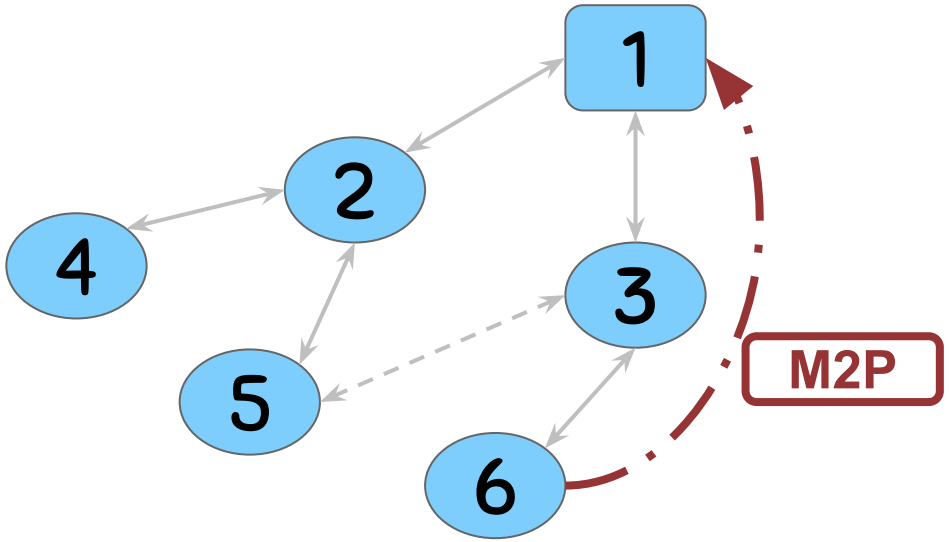
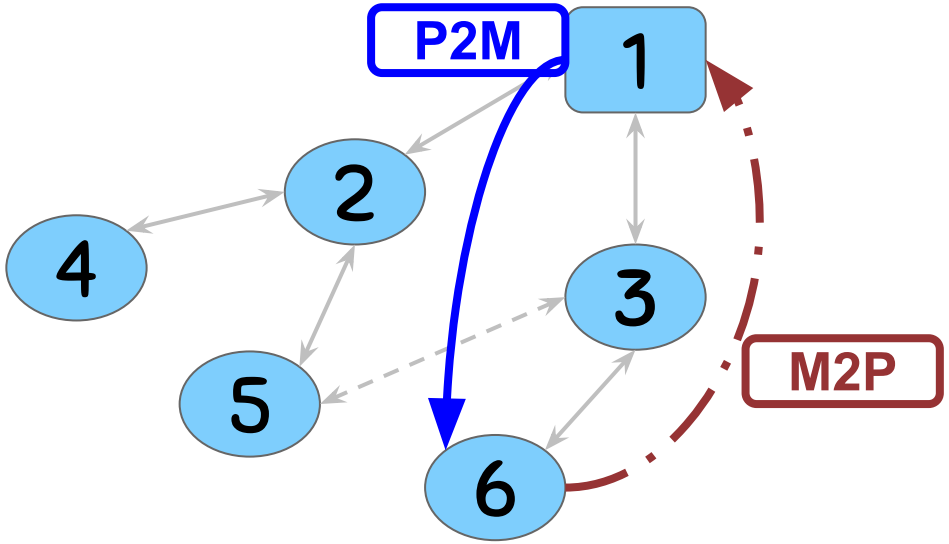


Data traffic patterns
over routing structures

Mobility Detection

IoT routing in a nutshell



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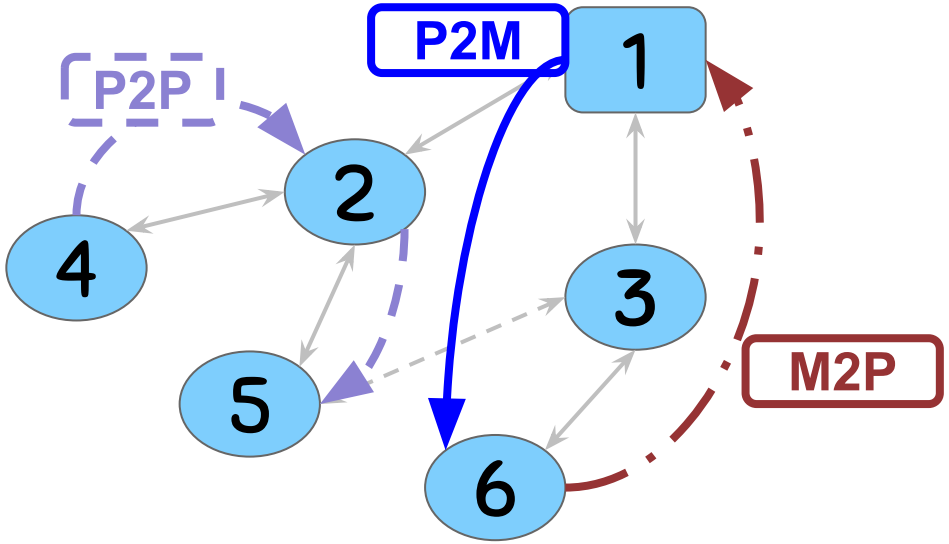


Data traffic patterns
over routing structures

IoT routing in a nutshell

- Literature routing protocols
  - RPL (*de facto* the state-of-the-art)
    - Several RPL adaptations for mobile scenarios
      - Co-RPL, MRPL, MMRPL, ERPL...
  - Mobile Matrix
  - Hydro
  - XCTP

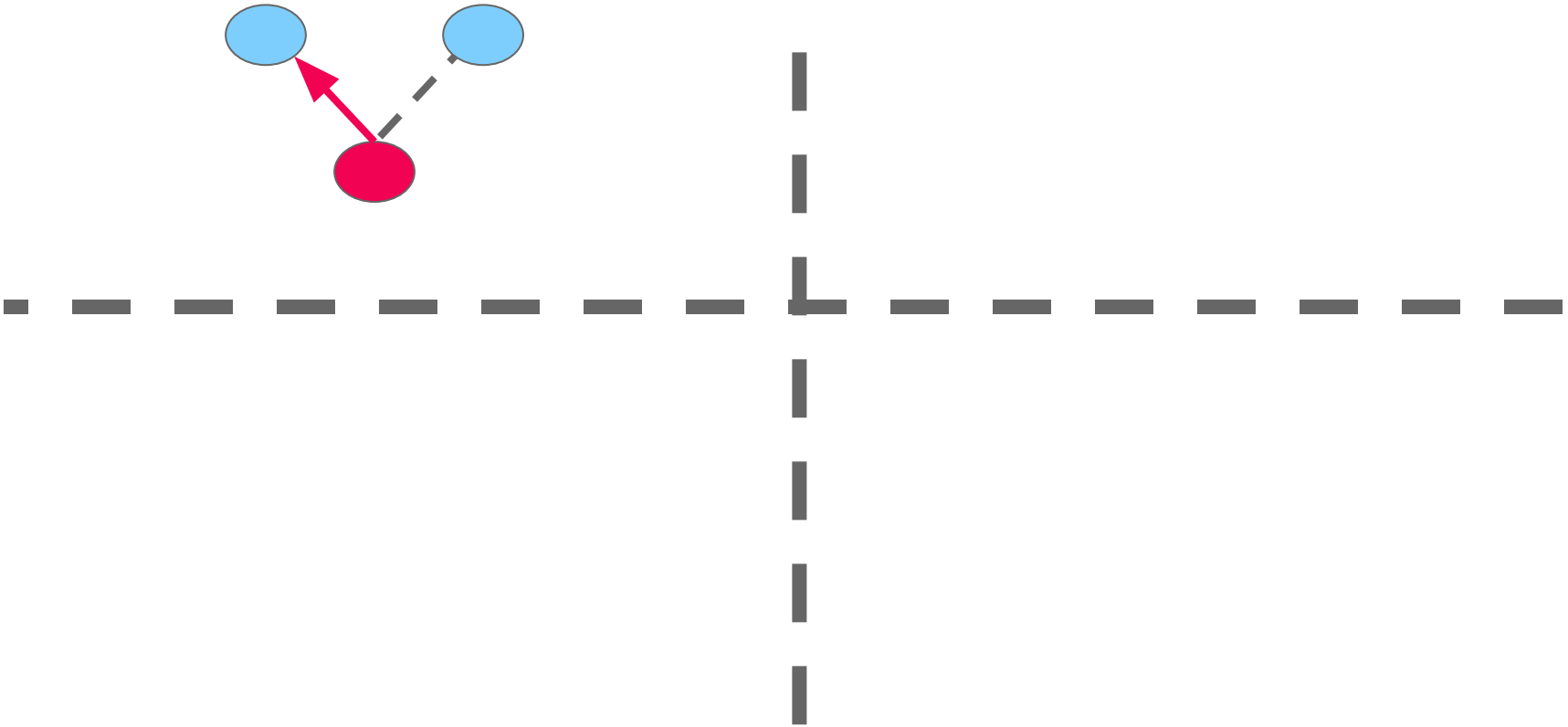
Mobility Detection

Routing under mobility events

- Mostly of routing protocols for mobile IoT have one timer scheme
  - It governs the communication structure construction and maintenance

Routing under mobility events

Example. (note there are other solutions)



Routing under mobility events

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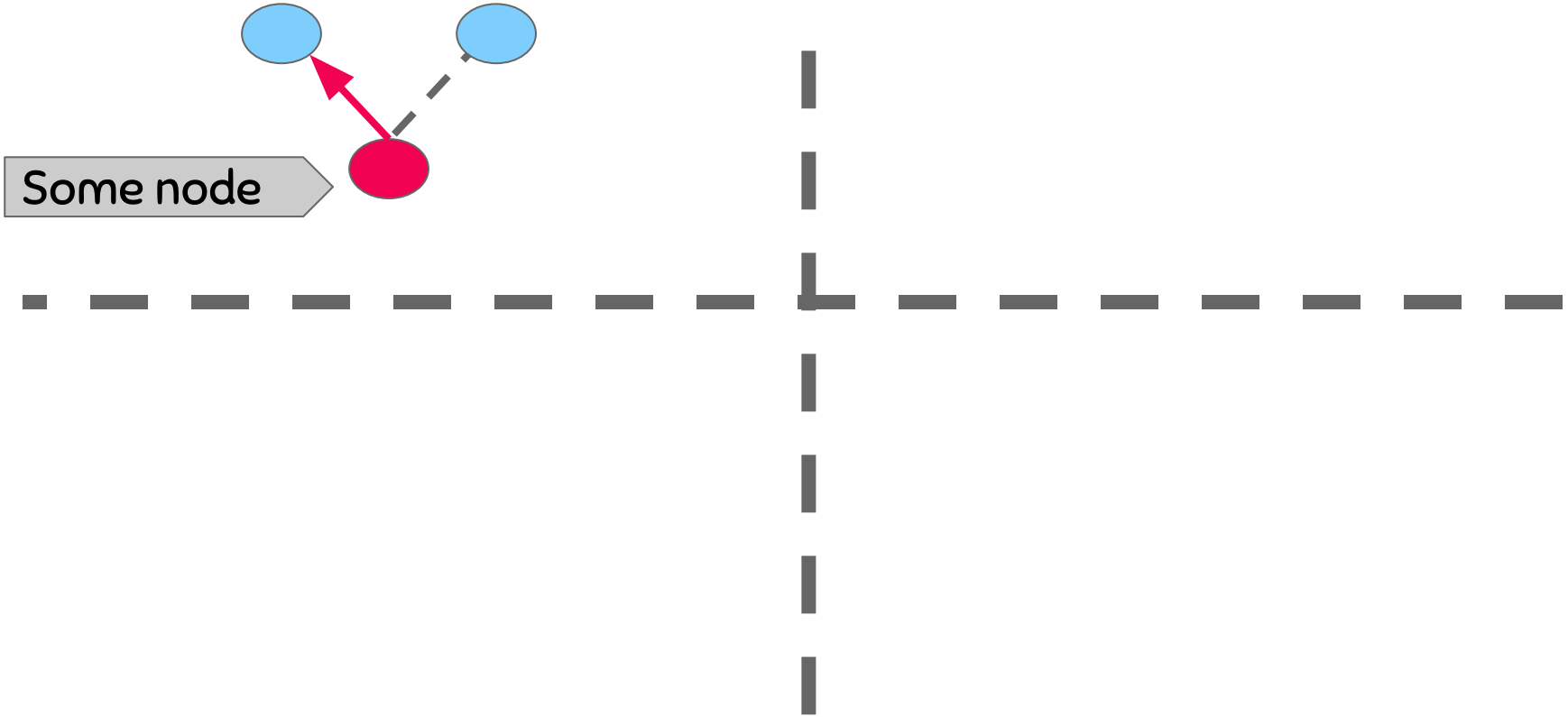

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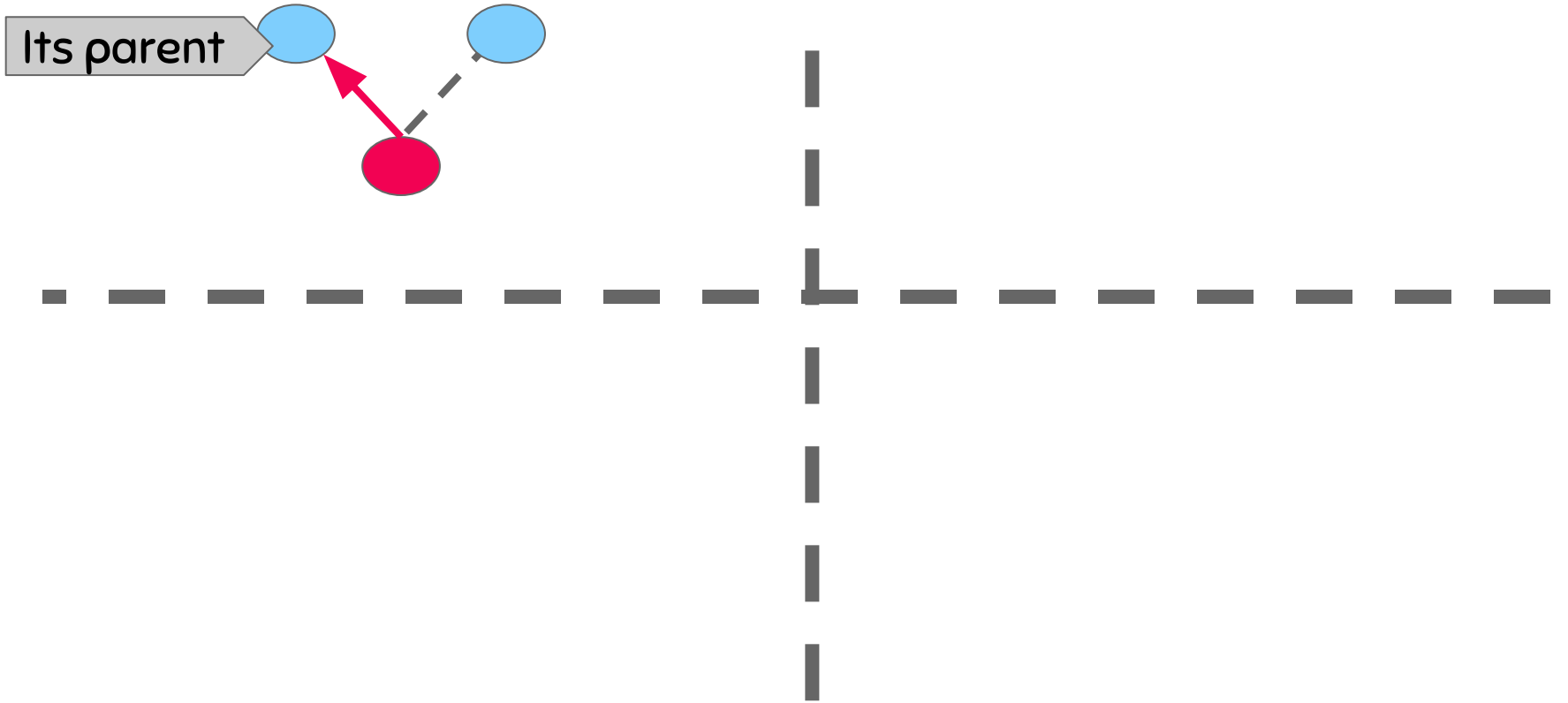

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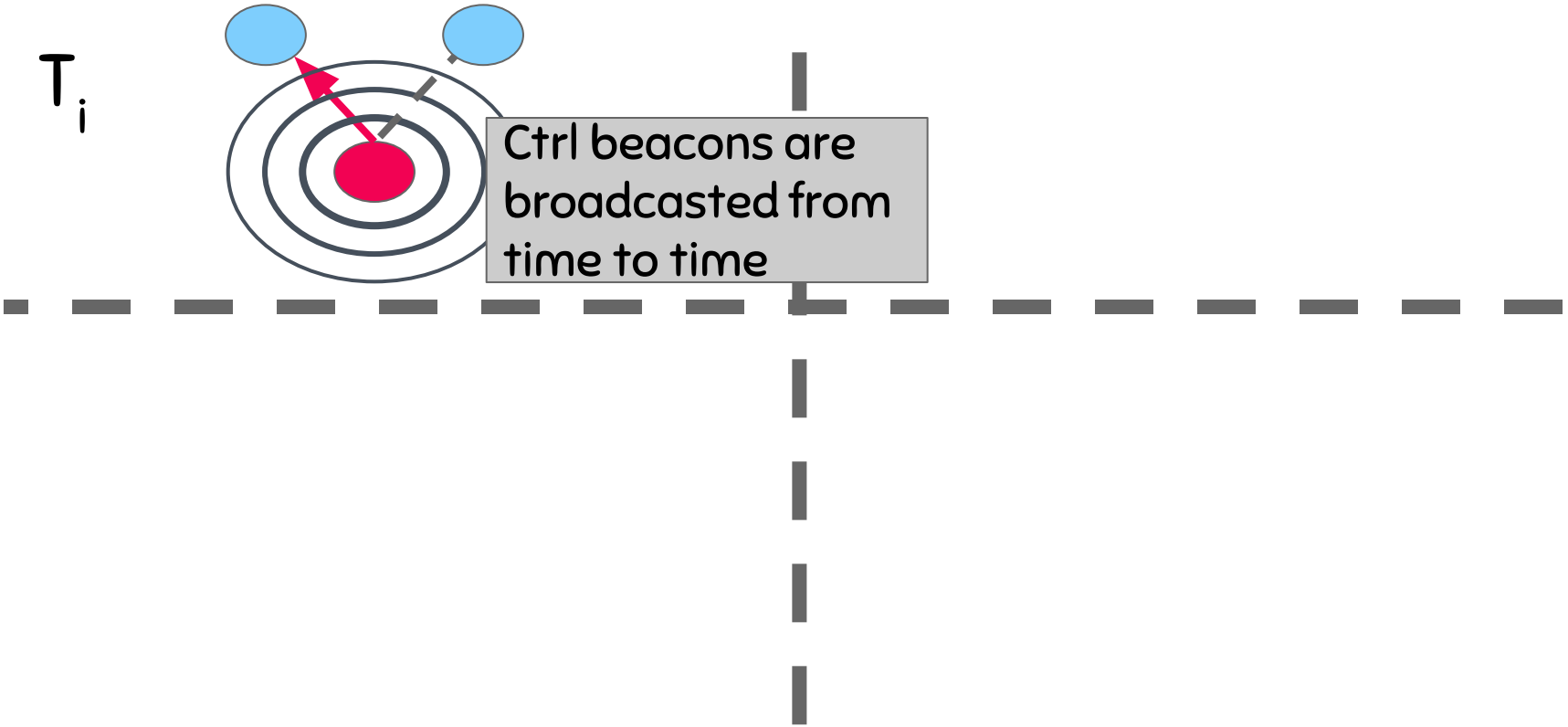

Routing under mobility events

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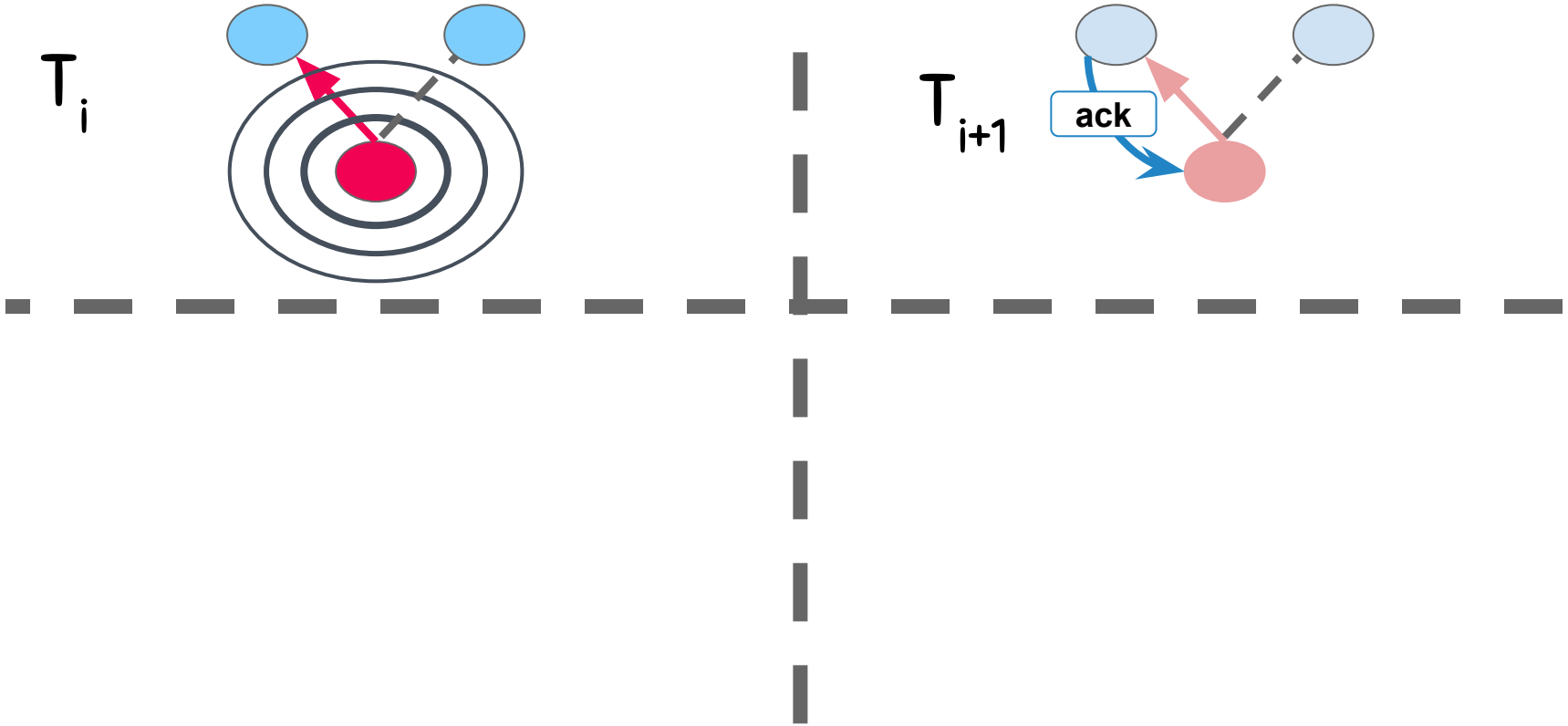

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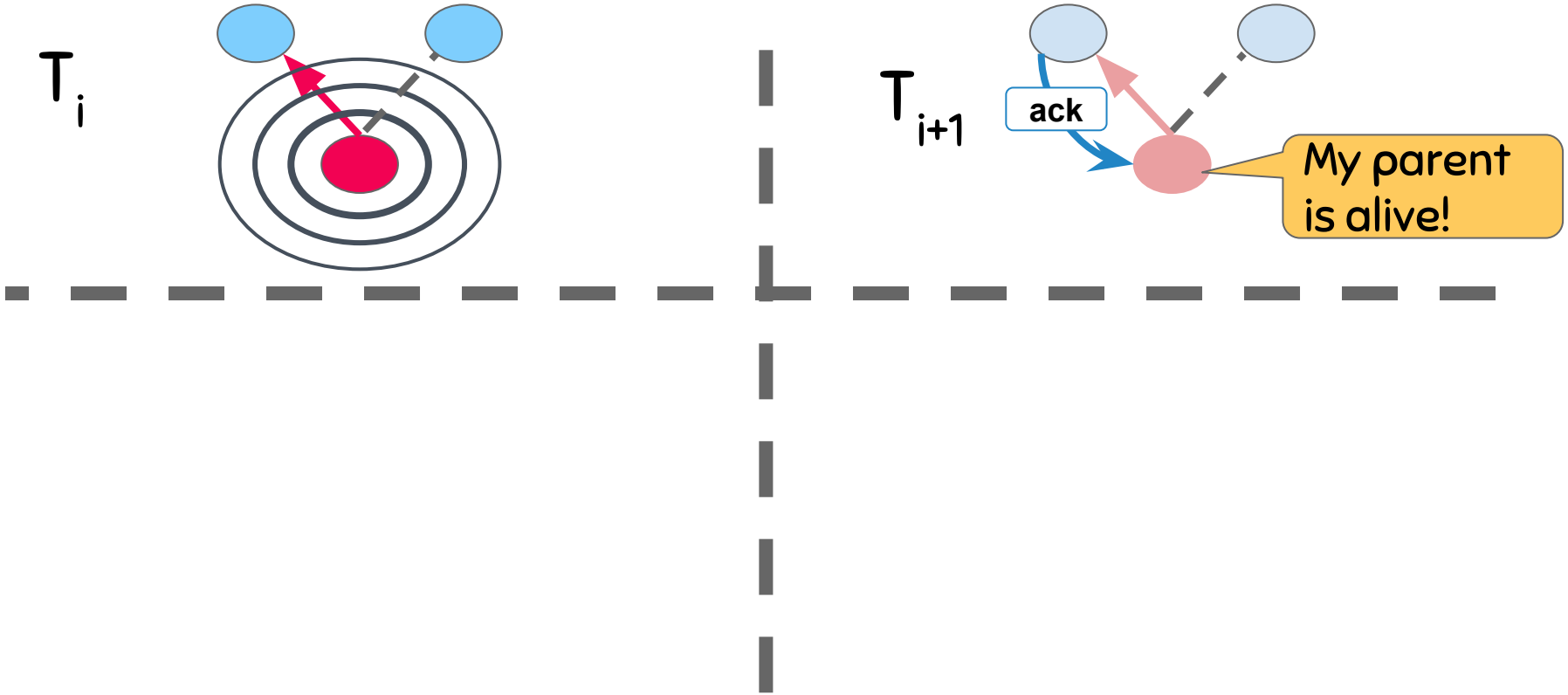

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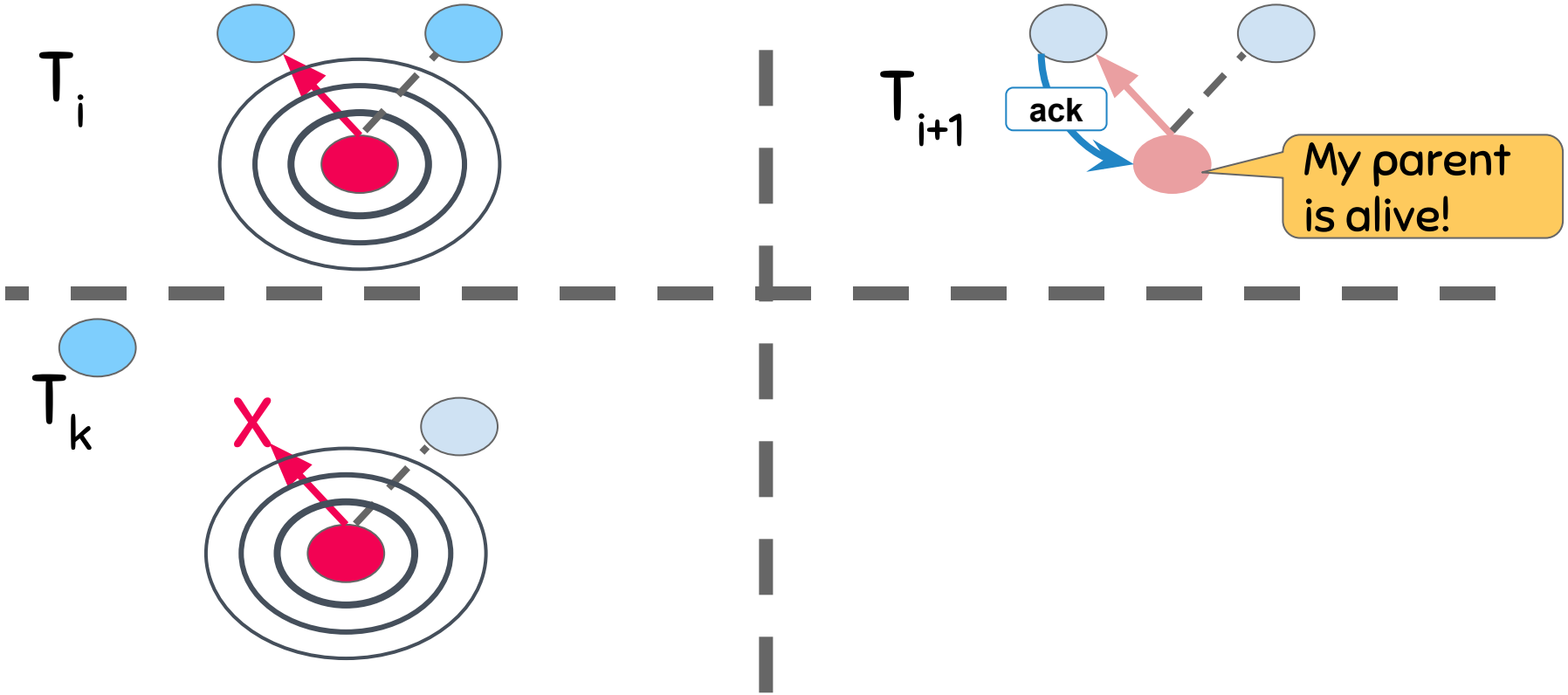

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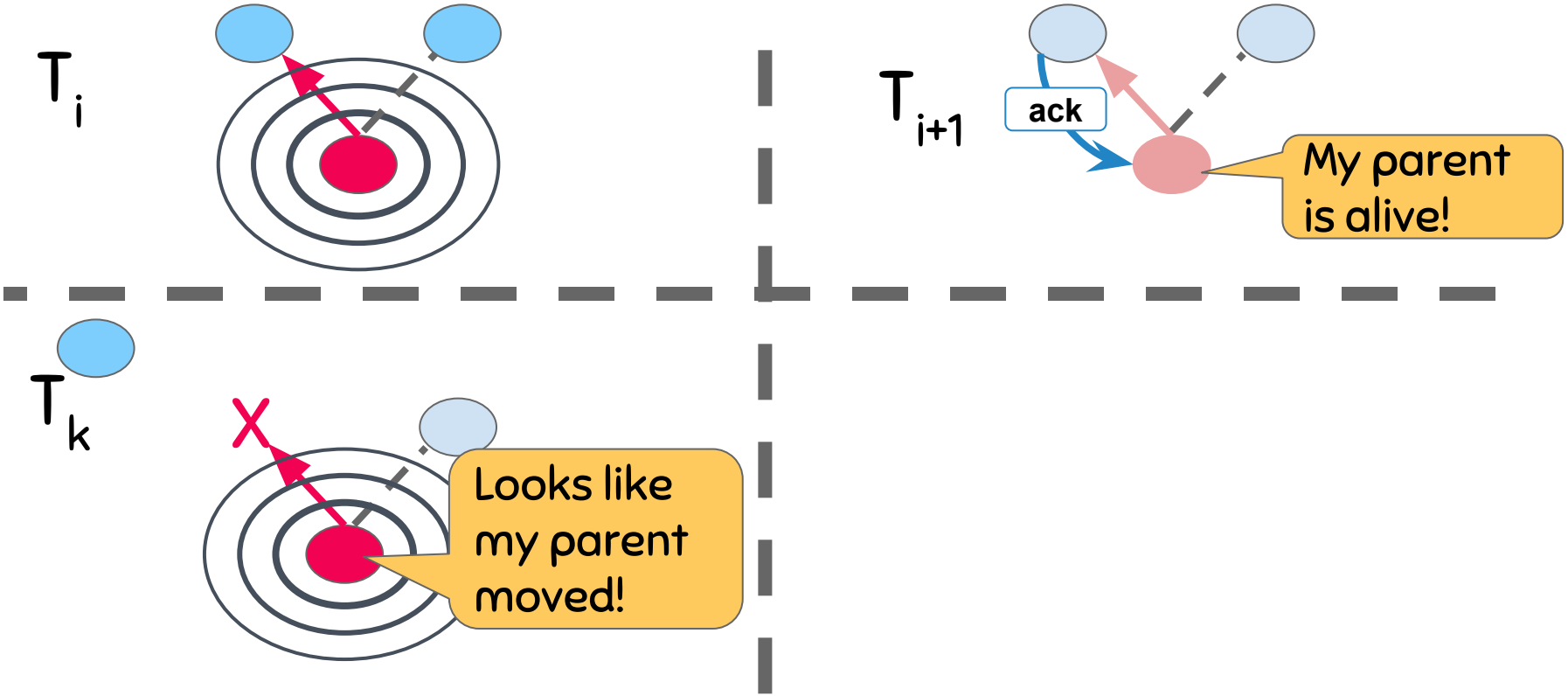

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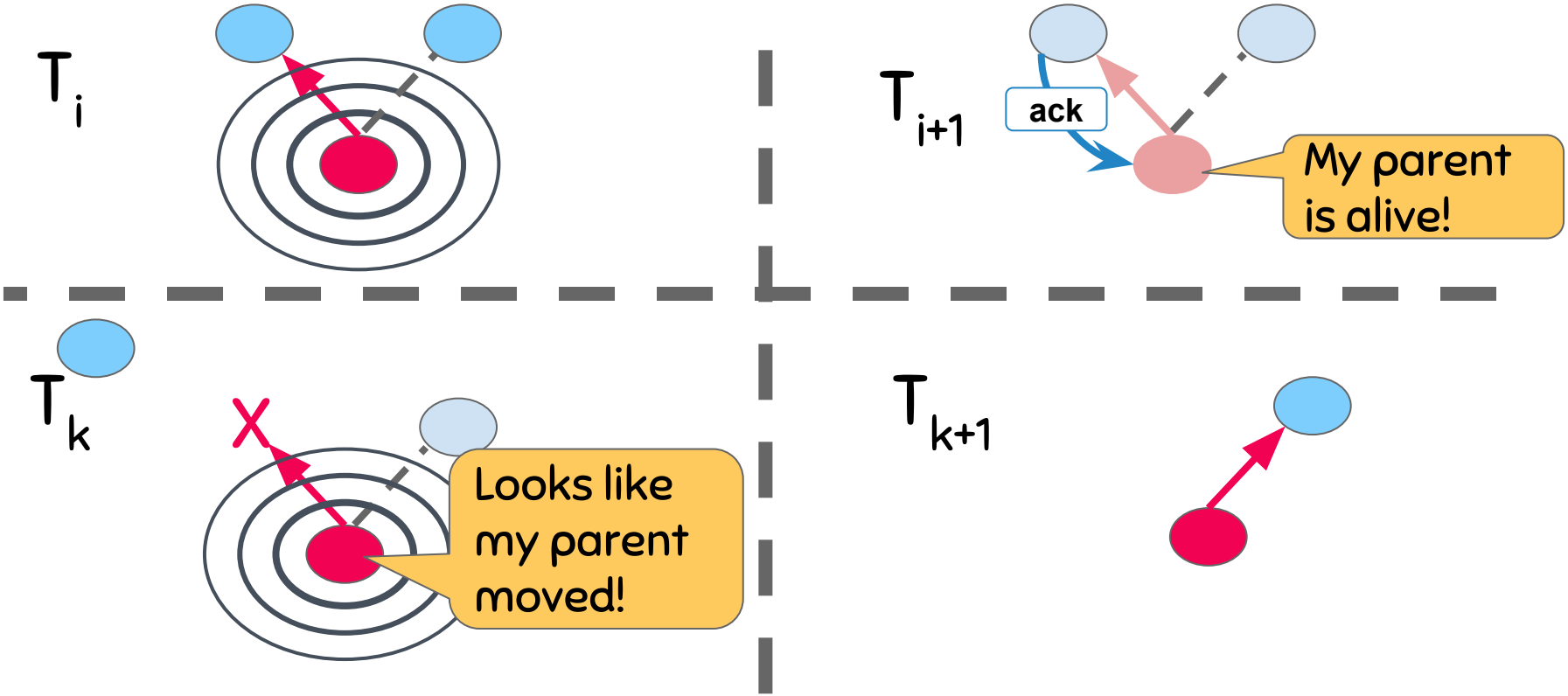

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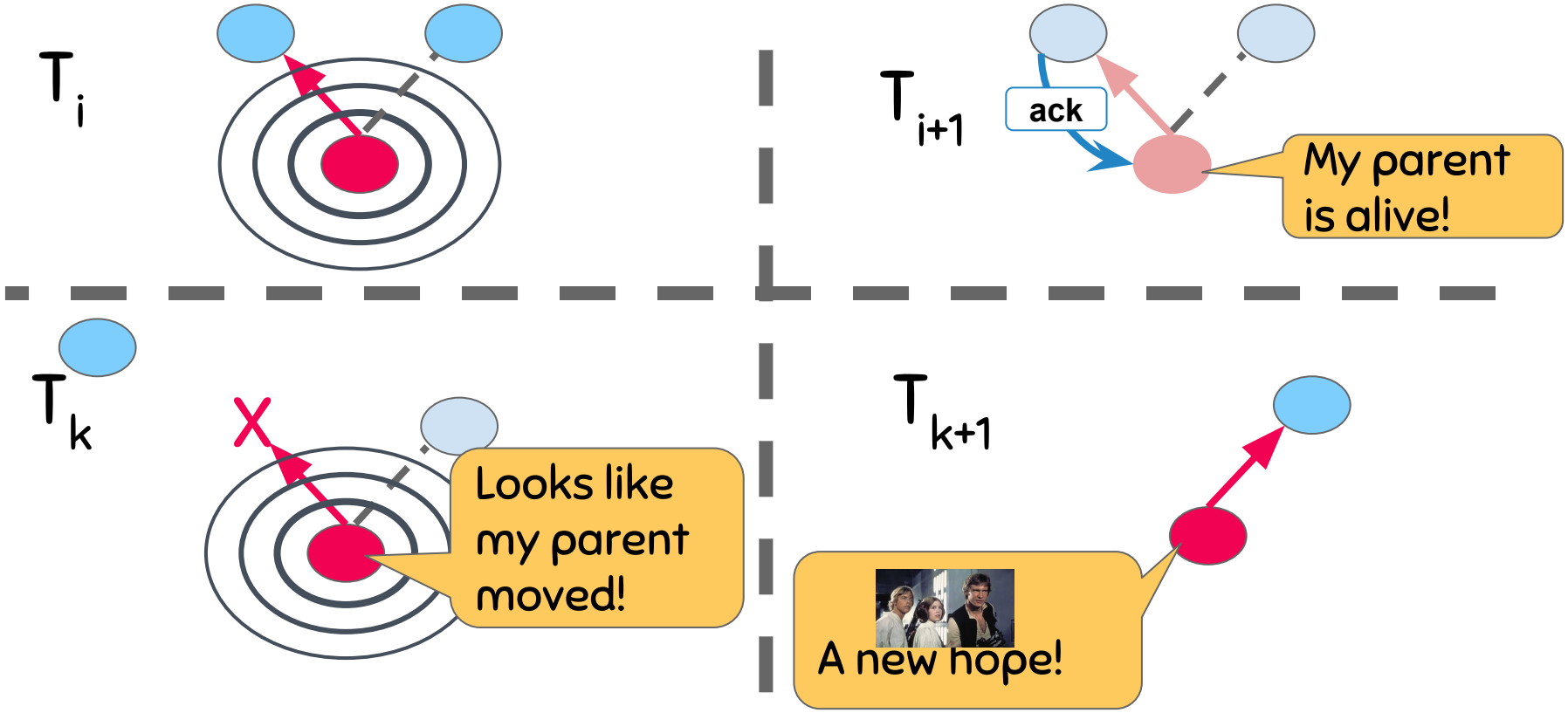
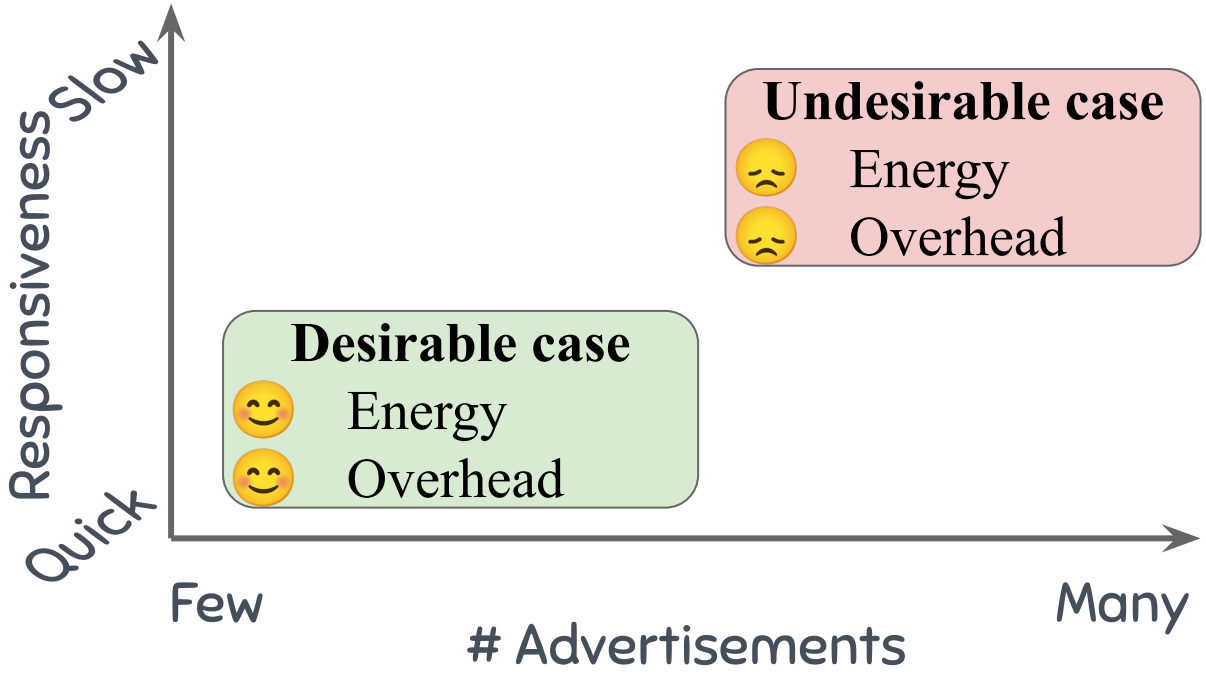
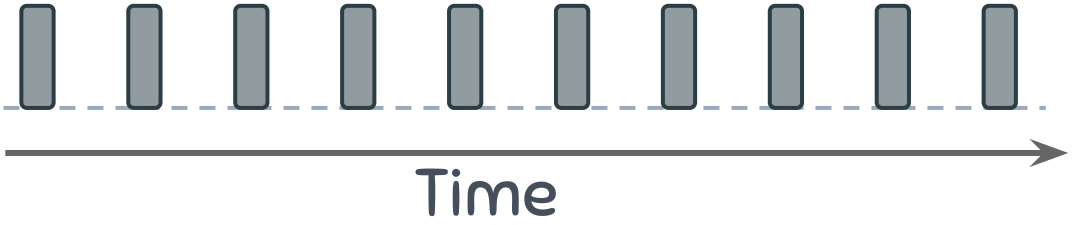


Timer scheme trade-off



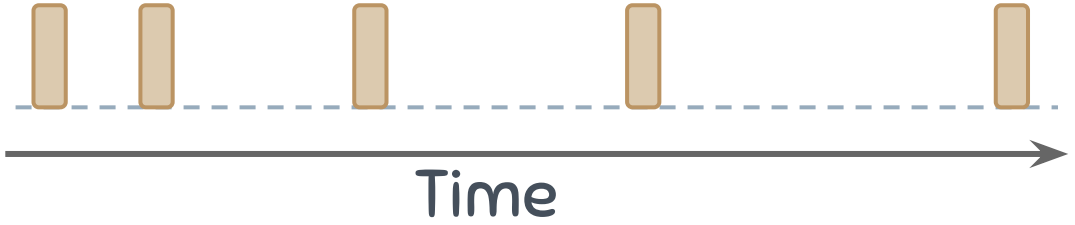
Mobility Detection

Dealing with mobility and link dynamics



- **Periodic**
  - Large interval
    - 😊 Low channel and energy usage
    - 😟 Slow responsivity
  - Small interval

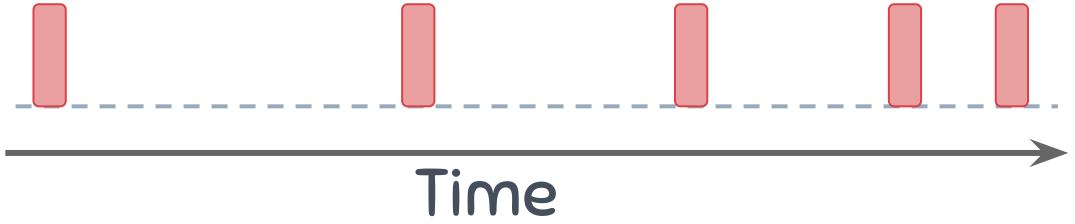
Dealing with mobility and link dynamics



- **Trickle Timer**
  - Assumes that network will be stable (few link changes)
  - Fires bursts of advertisements when some inconsistency is detected
  - Decrease advertisement rate exponentially

Mobility Detection

Dealing with mobility and link dynamics



- **Reverse Trickle Timer**
  - The “opposite” of Trickle Timer
  - Assumes that as long as a node remains connected to a parent, it’s likely that the node will move away
  - Increases advertisement rate exponentially

Mobility Detection

Dealing with mobility and link dynamics

1. **Reverse Trickle Timer,**
2. **Trickle Timer,**
3. **Periodic.**

- Such schemes assume:
  - Only one scheme governs the entire network
  - All devices follow the same mobility pattern

A learn-based timer scheme selector for mobility management in IoT

- It learns the IoT device mobility pattern
- Automatically assigns a proper timer scheme
  - Better balance the timer scheme trade-off

Dribble

How it works...

Start with a default timer scheme

Ex:
Trickle Timer

Dribble

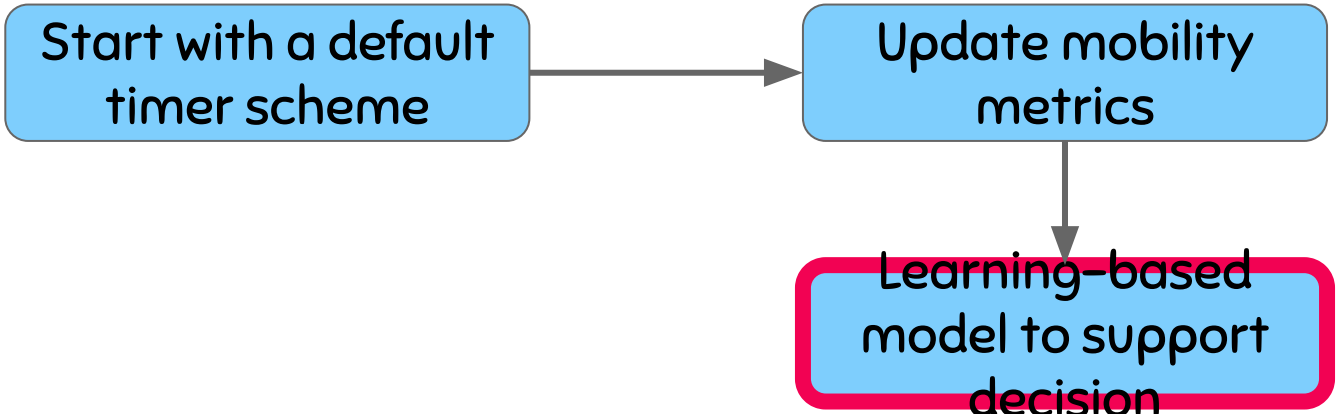
How it works...

Ex:

- **Speed,**
- **GPS,**
- **Travel Distance,**
- **Visit Time,**
- **Interconnection Time**

Dribble

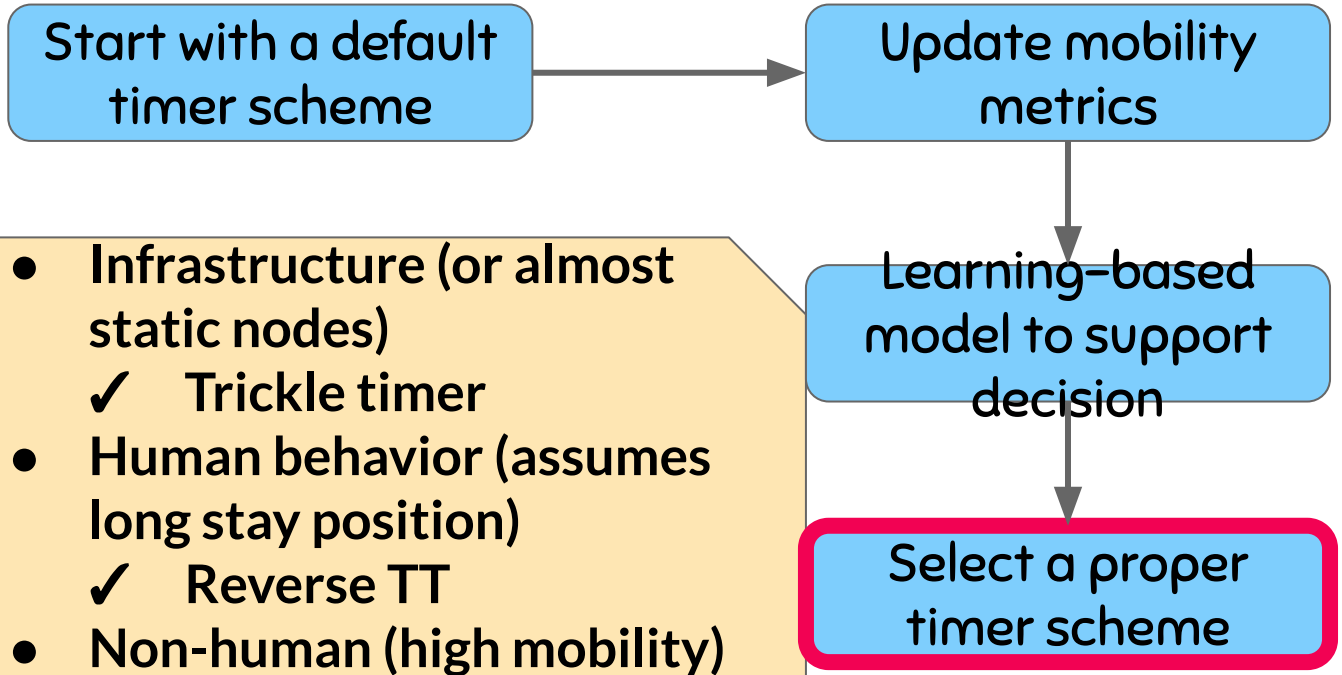
How it works...



- We've tested
  - Supervised and unsupervised models
  - But we have labeled data
- Multi-Layer Perceptron classifier as learning algorithm

Dribble

How it works...



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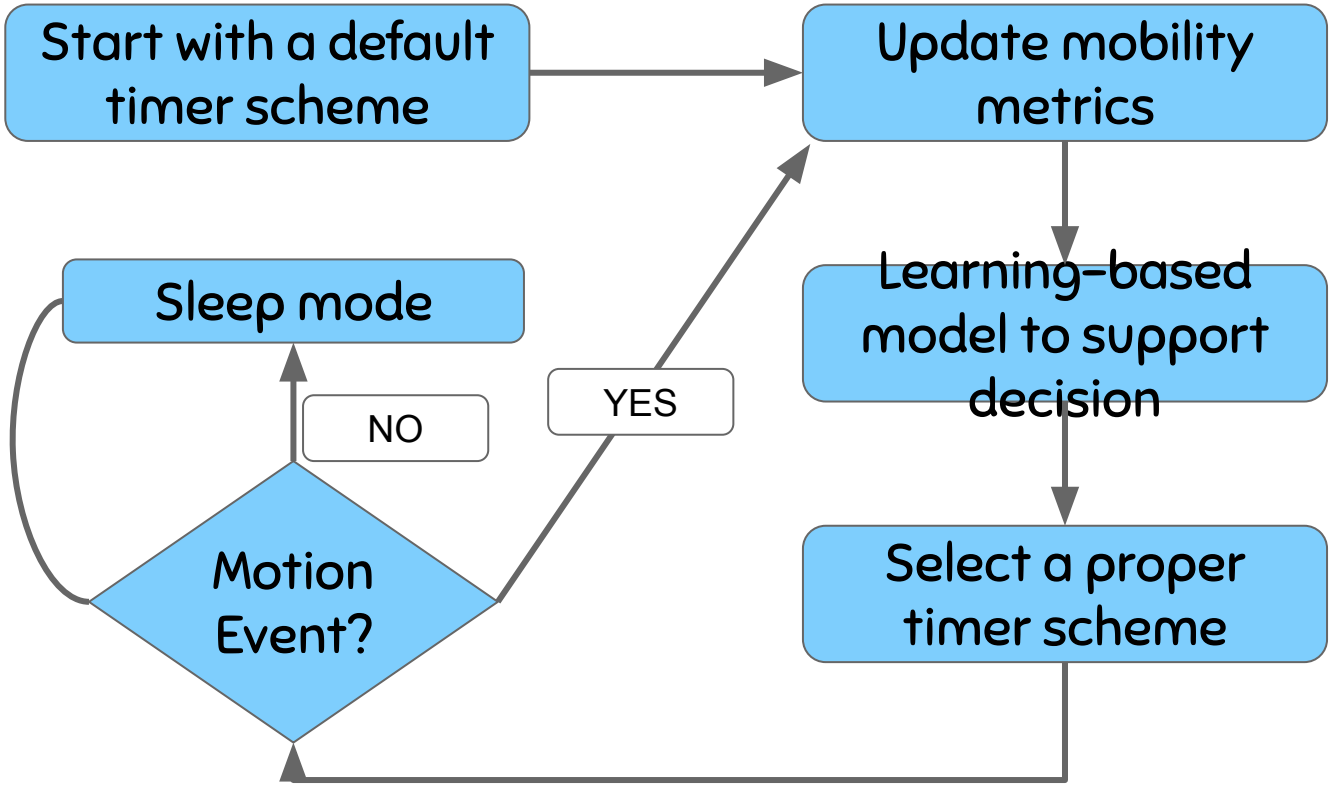
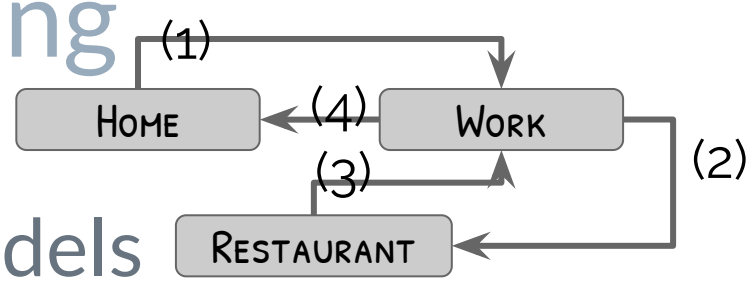

Start with a default timer scheme
Update mobility metrics
Learning-based model to support decision
Select a proper timer scheme
Motion Event?
YES
NO
Sleep mode

Evaluation

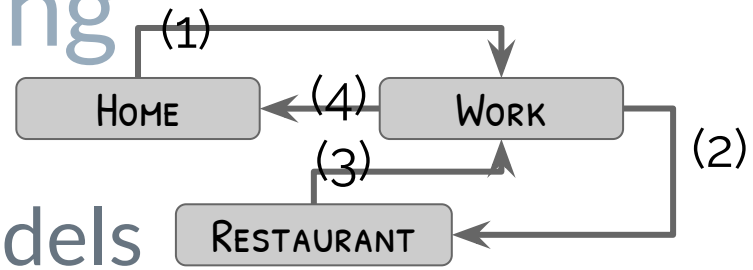
Device mobility modelling



- We use two mobility models
  - Group Regularity Mobility model (GRM)
    - Human-like

Evaluation

Device mobility modelling



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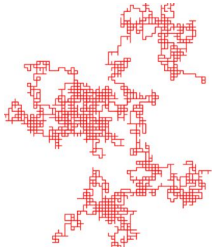
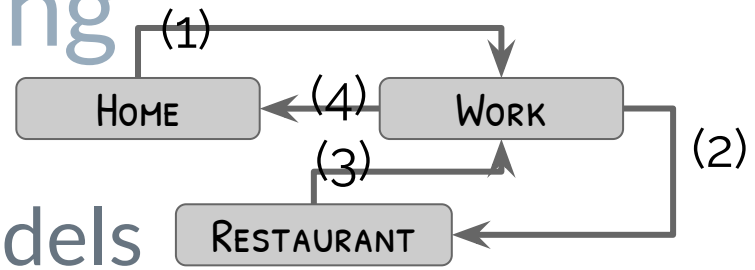
  - Cyclical Random Waypoint Mobility Model (CRWP)
    - Non-human



Evaluation

Device mobility modelling



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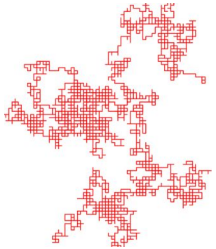
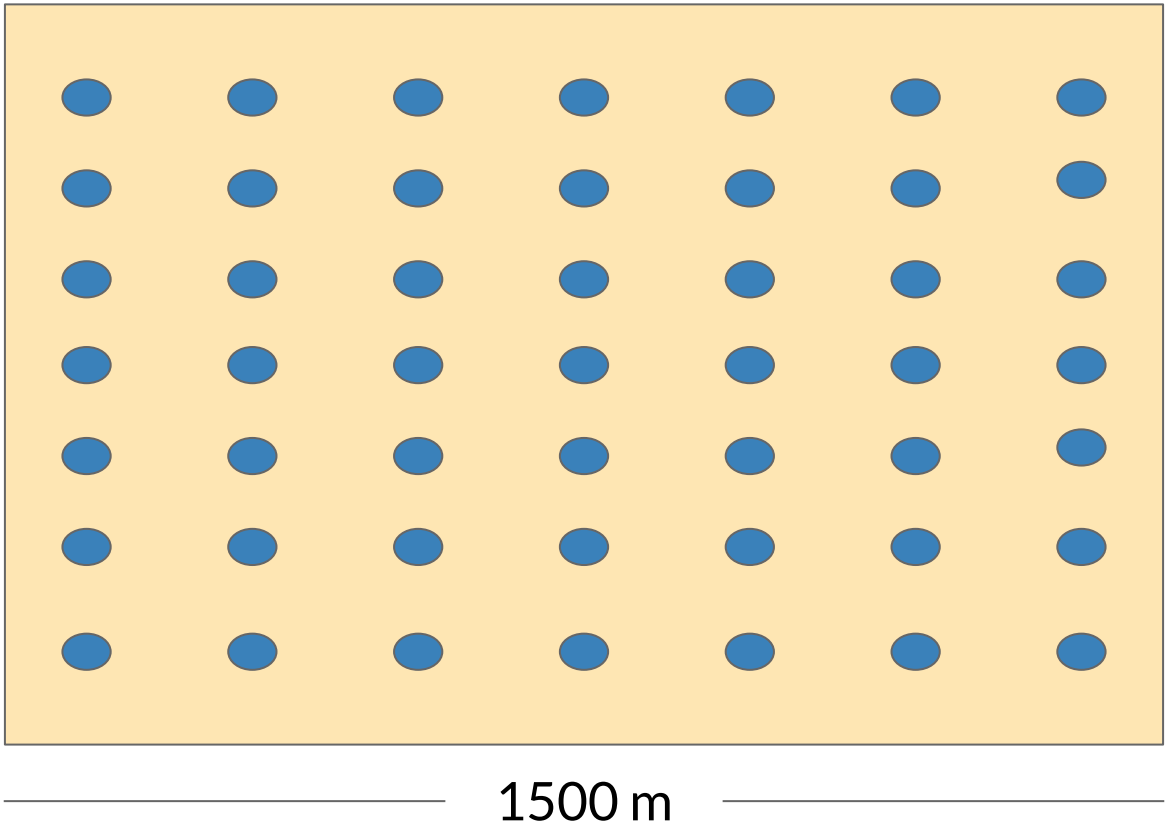
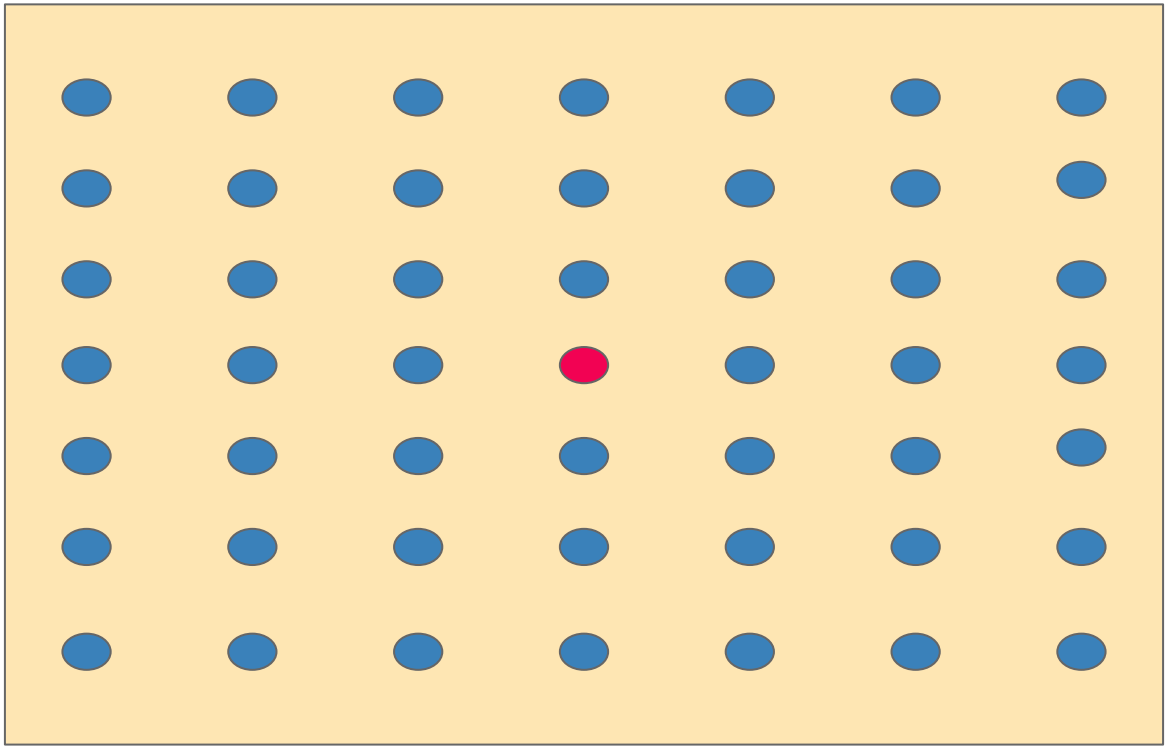


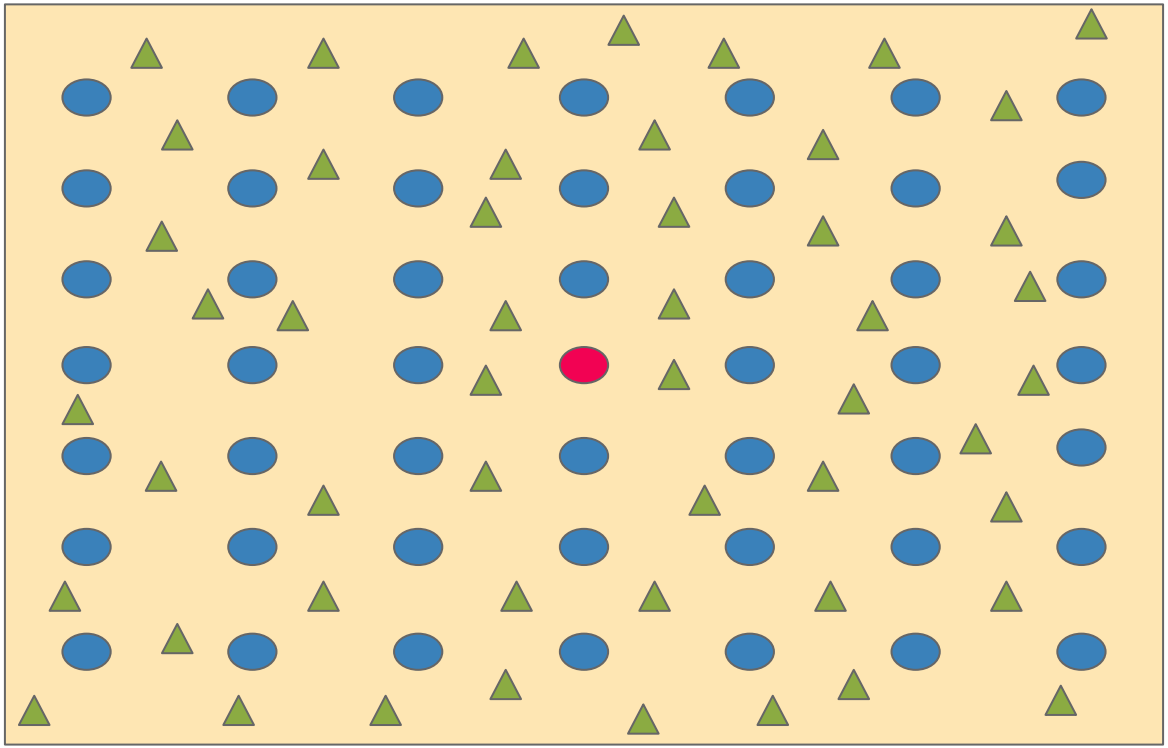
49 Static



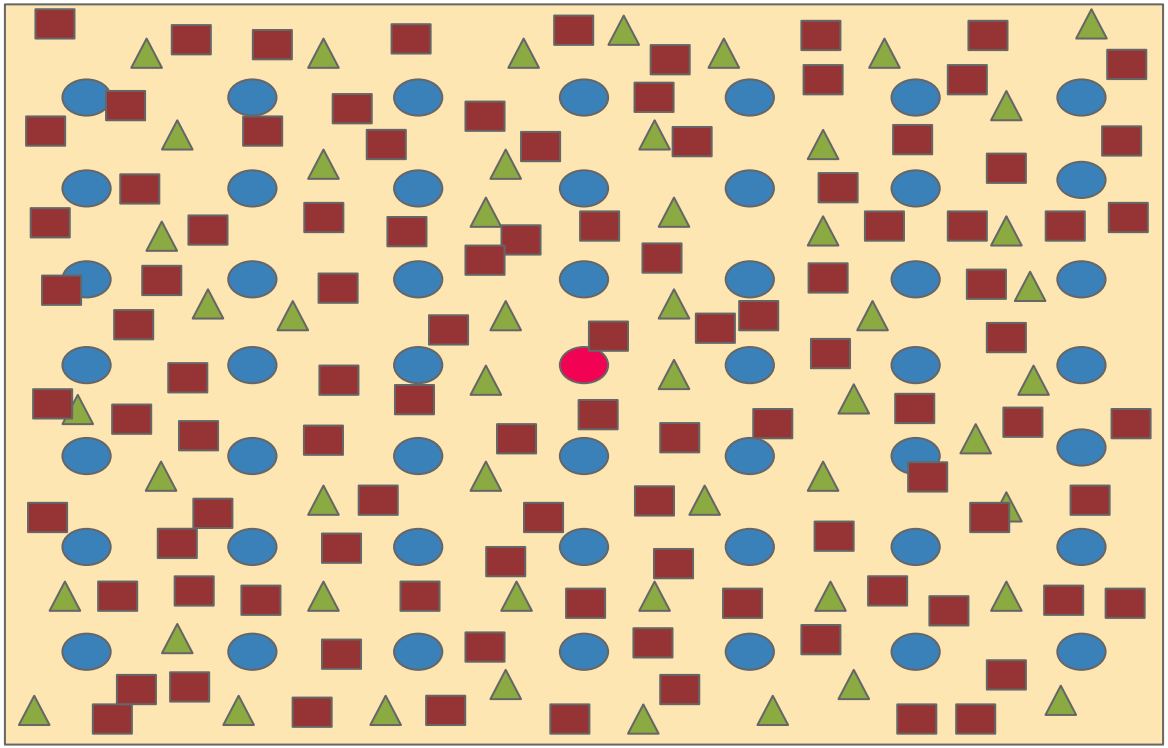
49 Static
1 BR

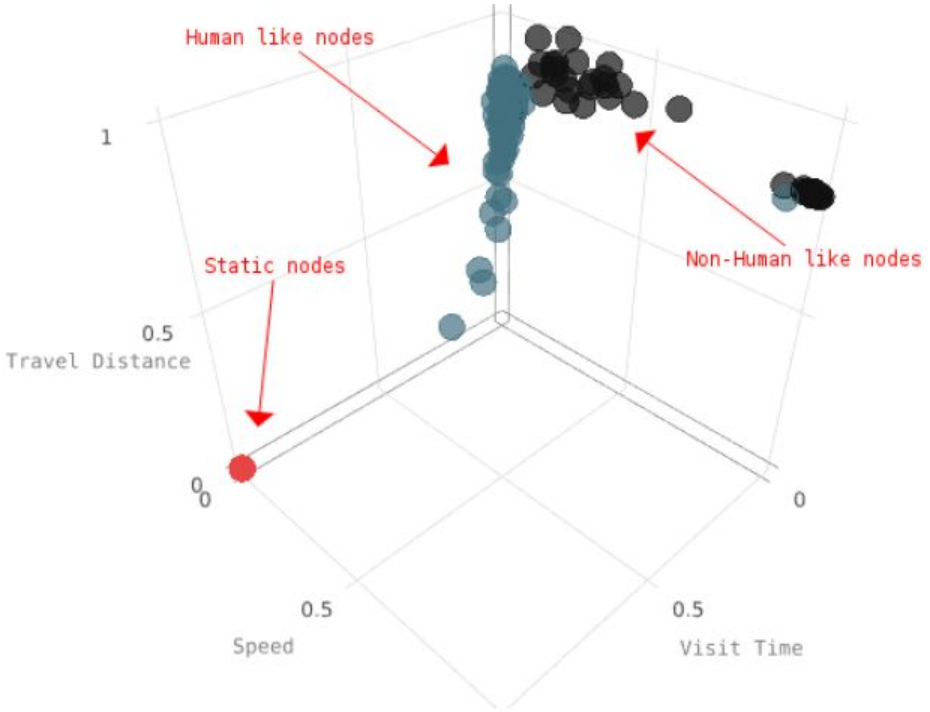


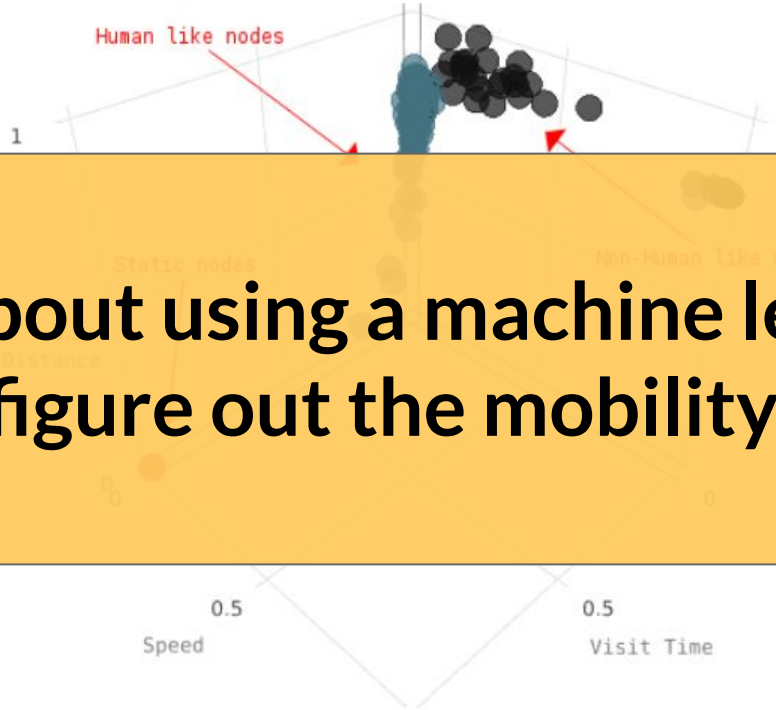
- 49 Static
- 1 BR
- 50 CRWP



49 Static
1 BR
50 CRWP
100 GRM




Human like nodes
Static nodes
Non-Human like nodes
1
0.5
Travel Distance
0
0
0.5
Speed
0.5
Visit Time
0



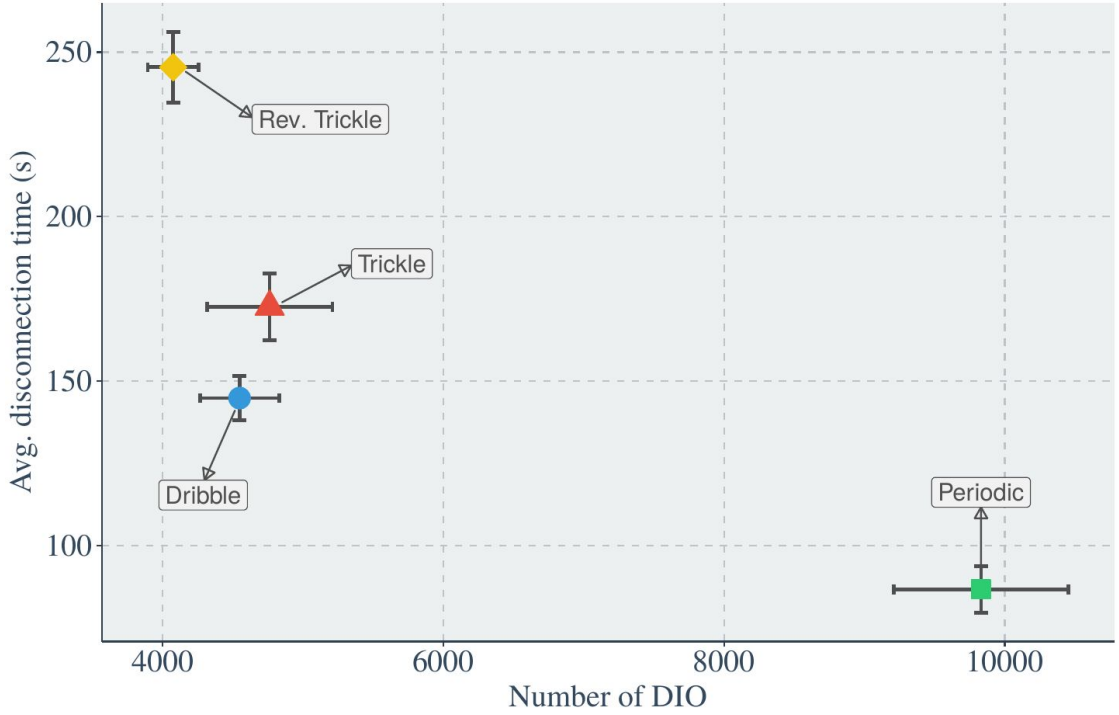
What about using a machine learning model to figure out the mobility pattern?

Neural Network (Multi-Layer Perceptron) Architecture and parameters	
Architecture	1 Hidden layer with 100 neurons
Activation	Rectified linear unit function
Learning rate	Constant
# epochs	500
Weight optimization	Adam
Train dataset	10 random topologies
Validation model	10-fold cross-validation

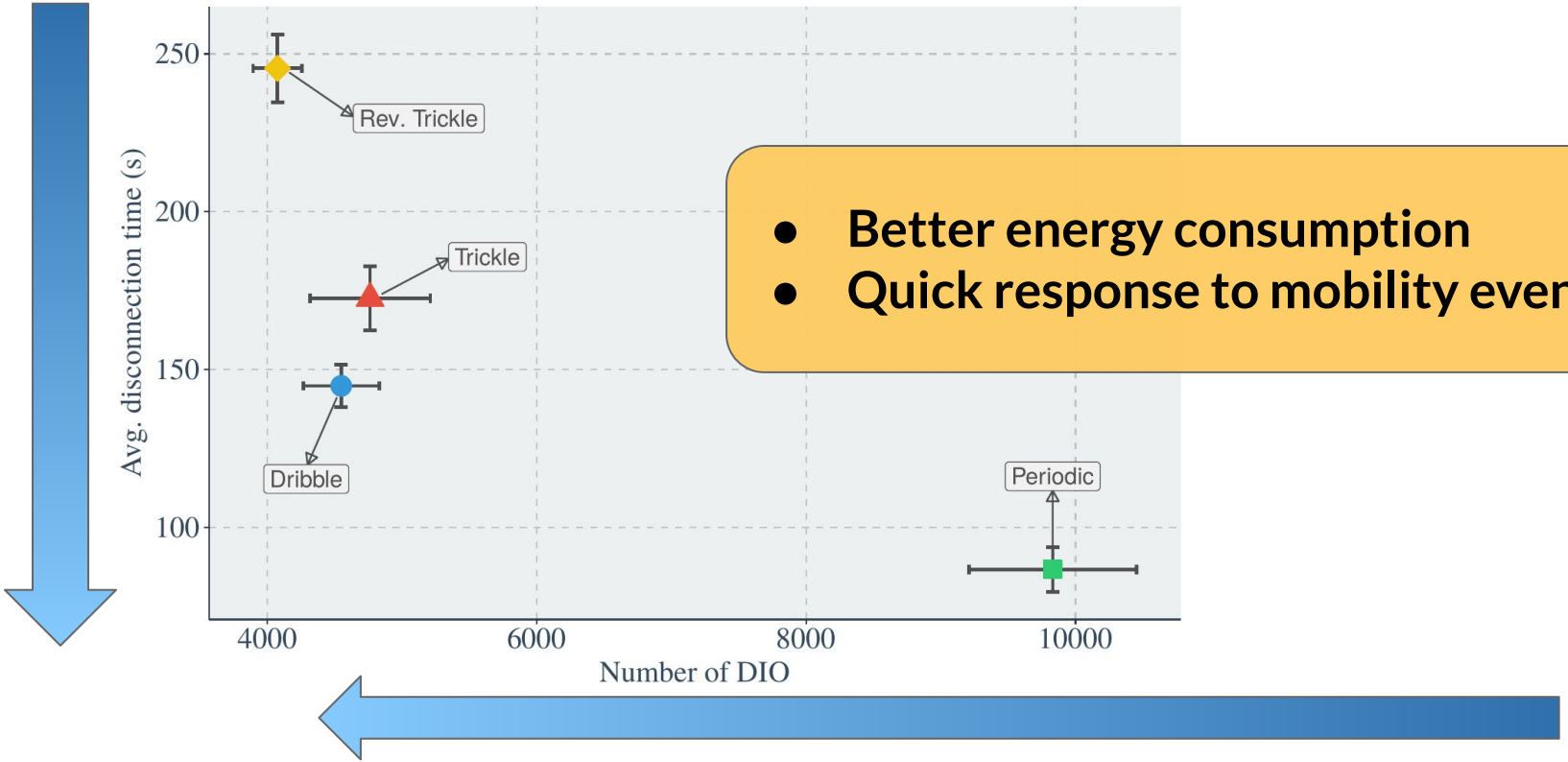
	Precision	Recall
Non-Human	1	0.99
Human	0.98	1
Static	1	0.96
Avg/Total	**0.99**	**0.99**

Evaluation

Trade-off balance



Trade-off balance



- Better energy consumption
- Quick response to mobility events

Reports

1. **Dribble: a learn-based timer scheme selector for mobility management in IoT.**
   IEEE WCNC 2019

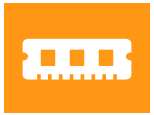
3.

An Alternative Routing Protocol for **Static** IoT

- ✓ Matrix
- ✓ Results
- ✓ Reports

Matrix Approach

Any-to-any routing



Memory efficiency

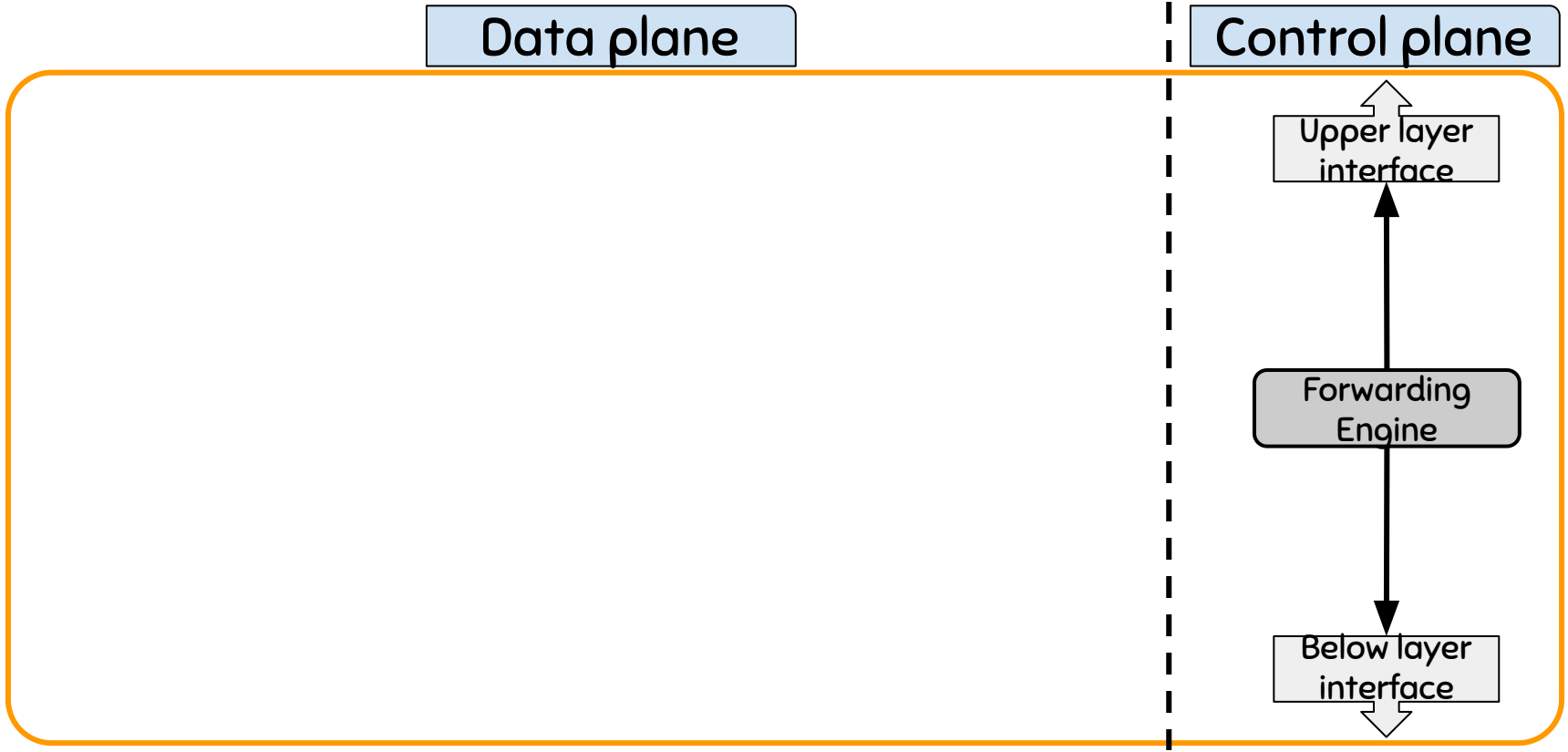
Reliability

Fault tolerance

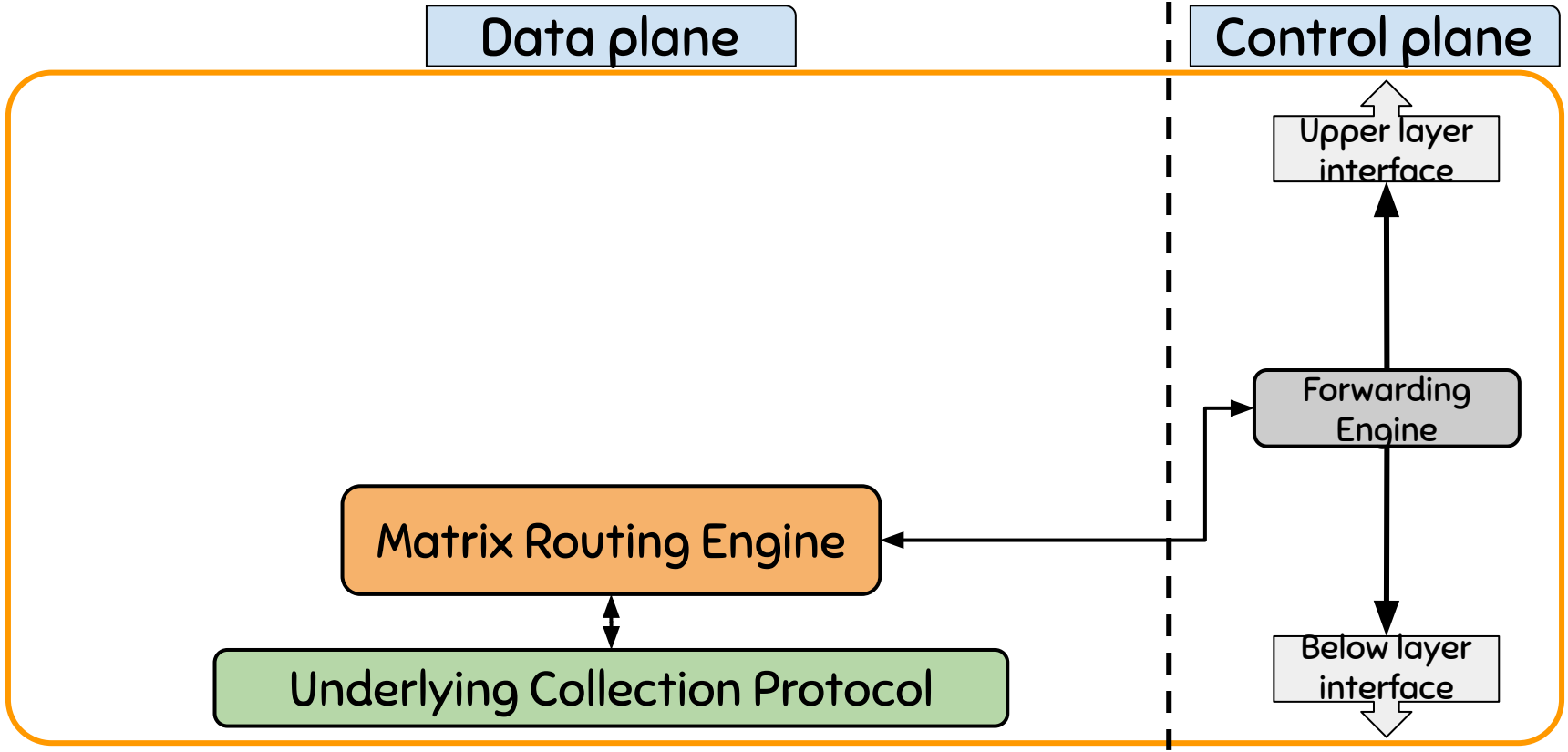
Hardware independence

IoT integration

Matrix's Architecture



Matrix's Architecture



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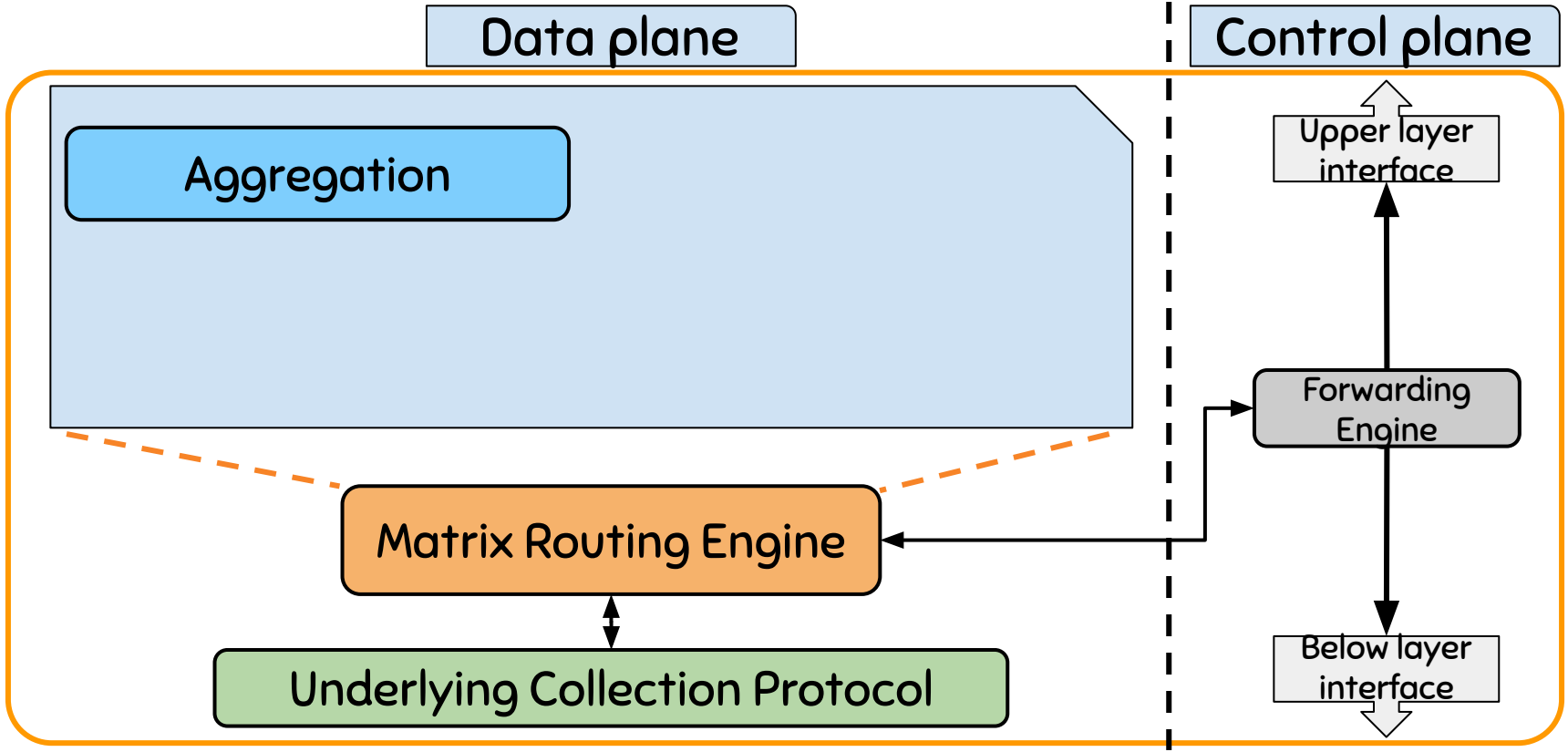
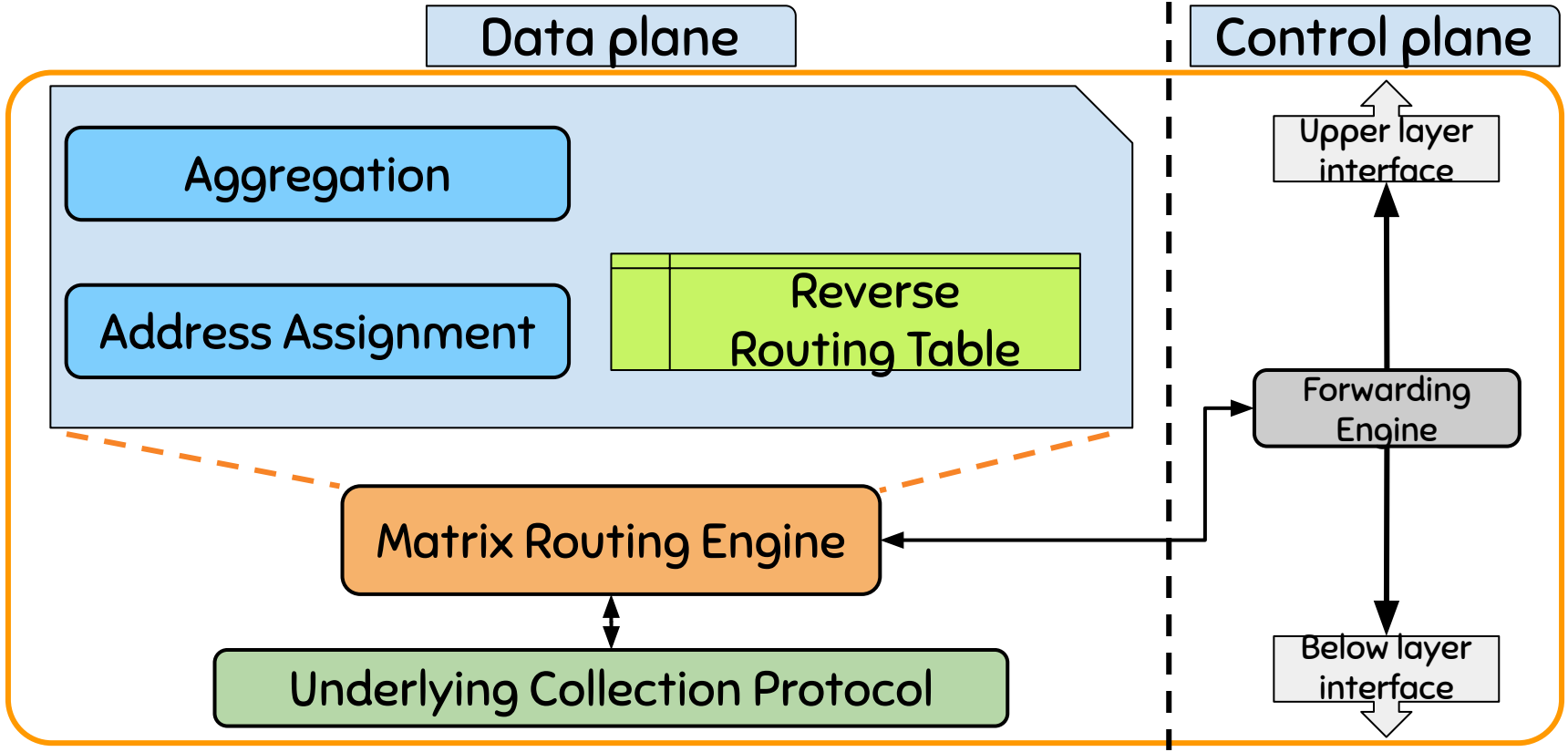


Matrix's Architecture



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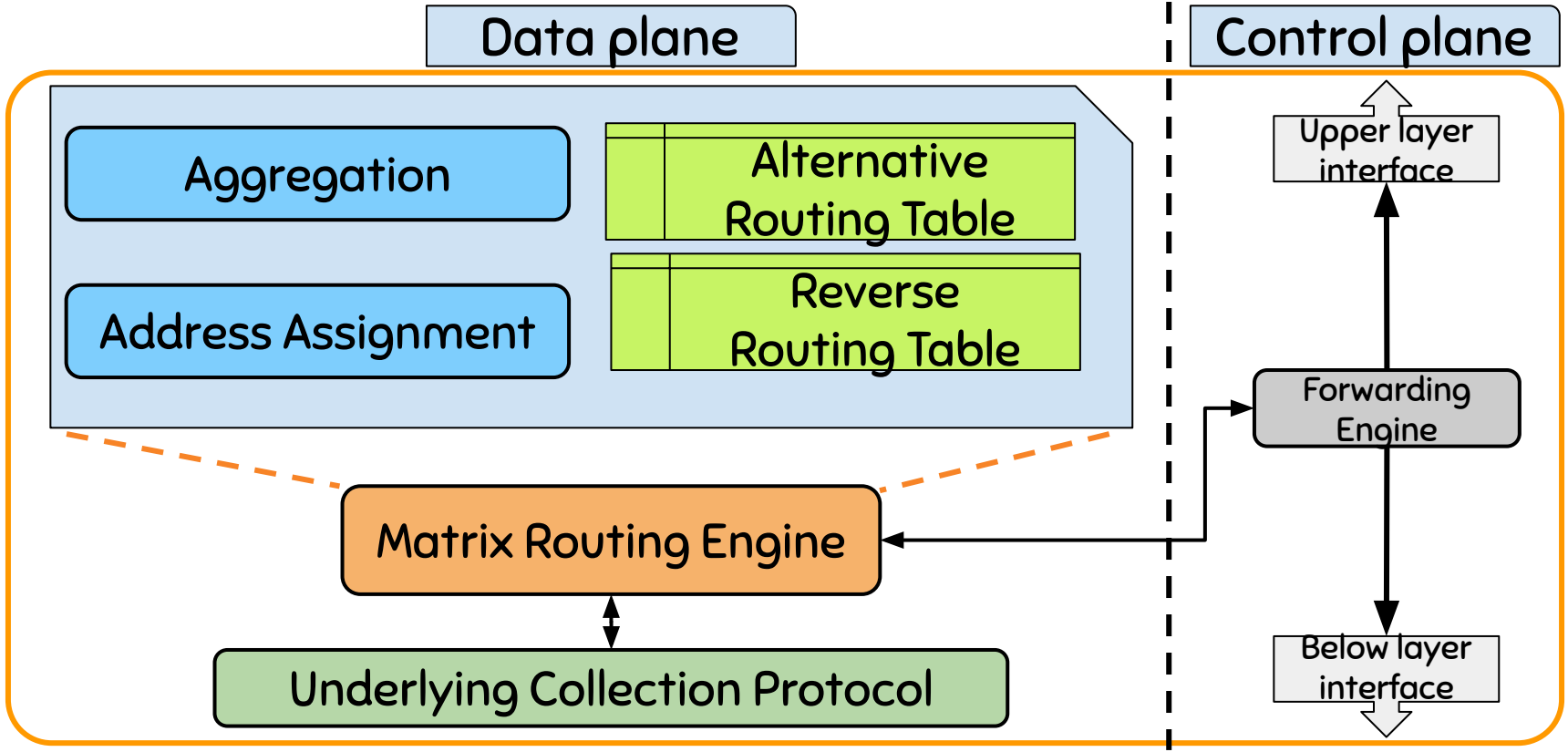
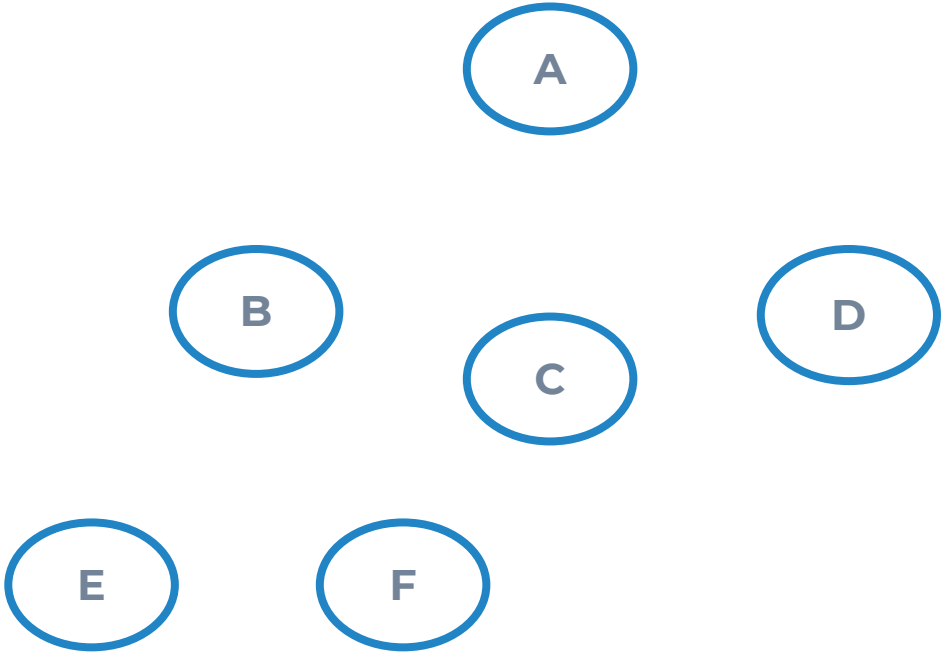
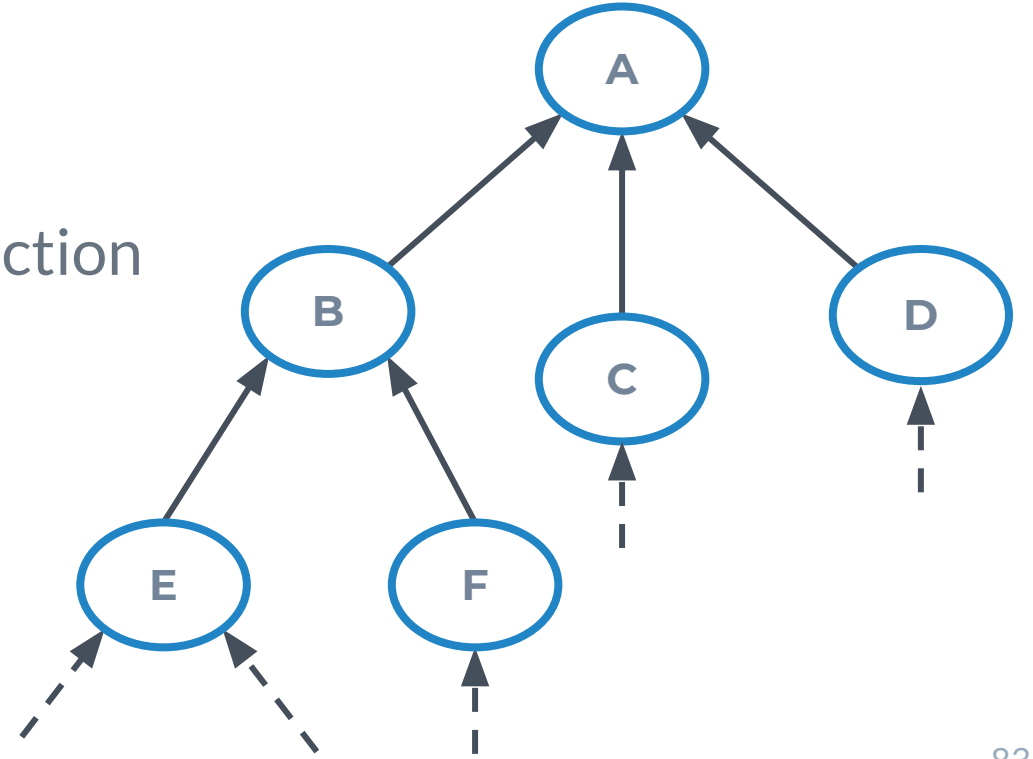


Matrix design



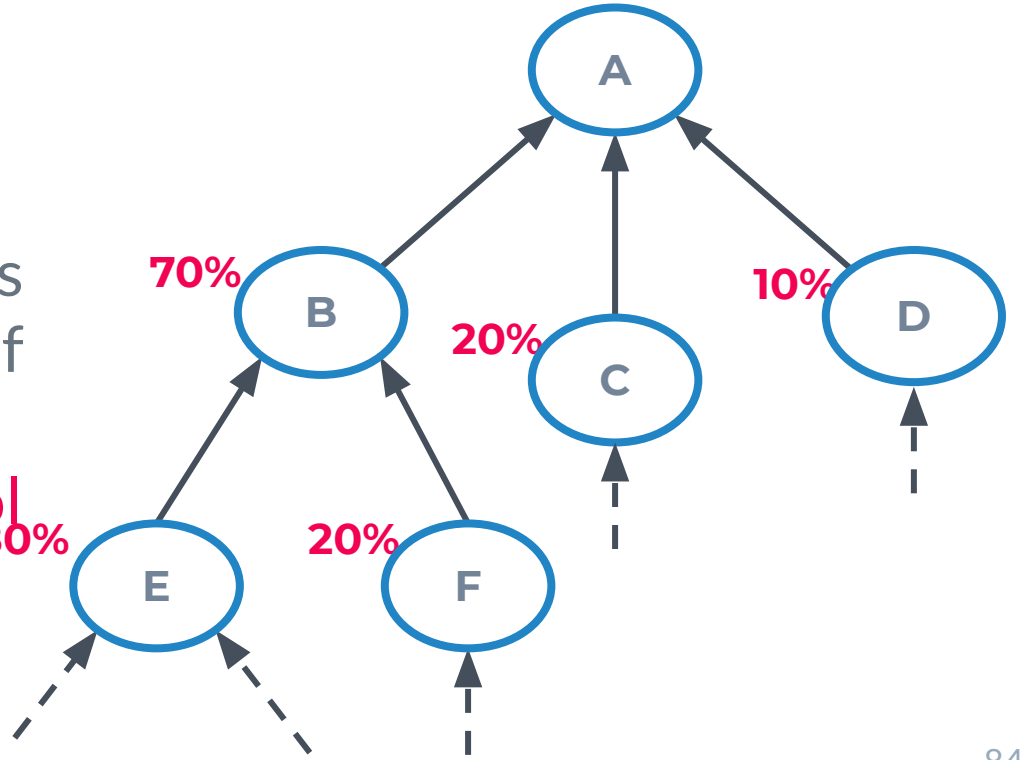
Matrix design

1. Tree Collection
   - Matrix relies on an underlying data collection routing protocol
     - Ex: RPL or CTP
   - It takes O(n) control messages



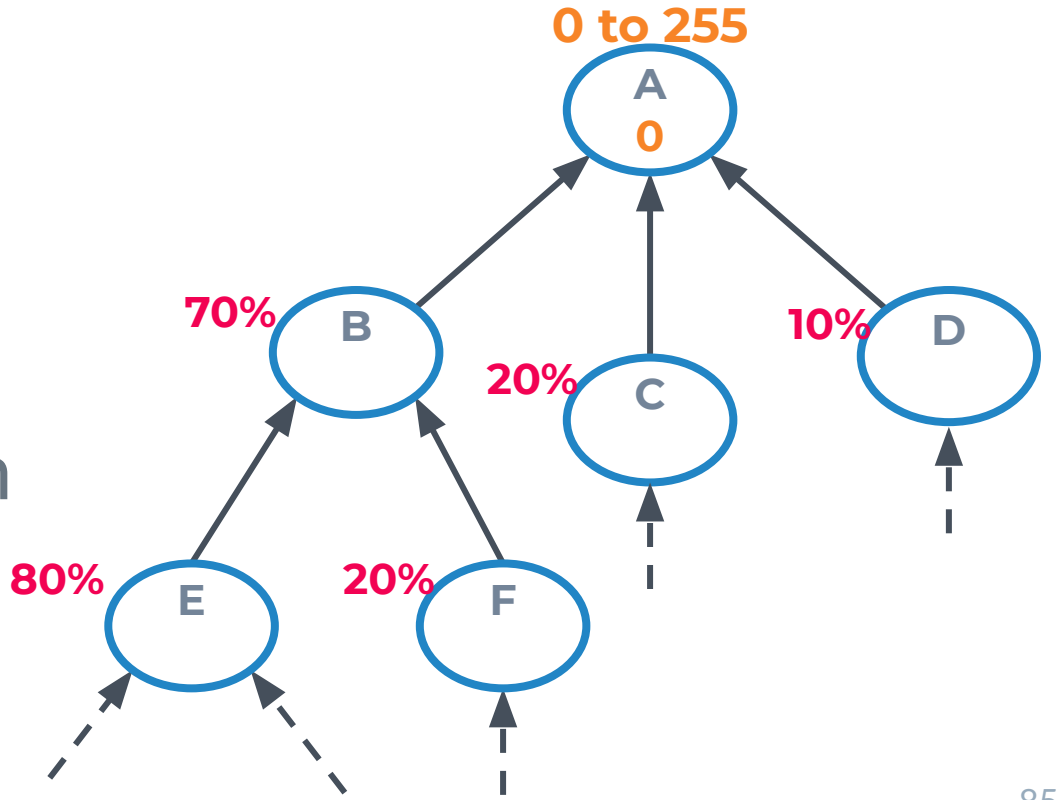
Matrix design

1. Tree Collection
2. Data aggregation
   - Each node informs the number of children
   - It takes O(n) control messages



Matrix design

1. Tree Collection
2. Data aggregation
3. Hierarchical Address Allocation
   - Node receives from parent a range of available IPs proportionally



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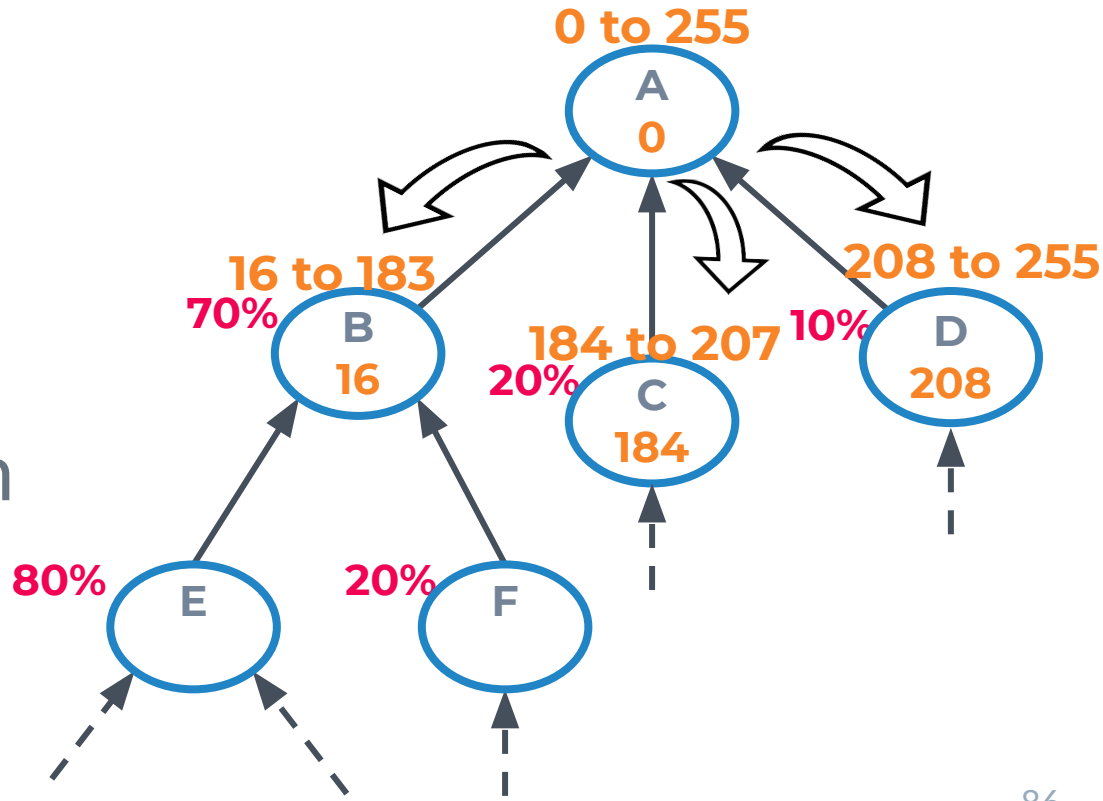

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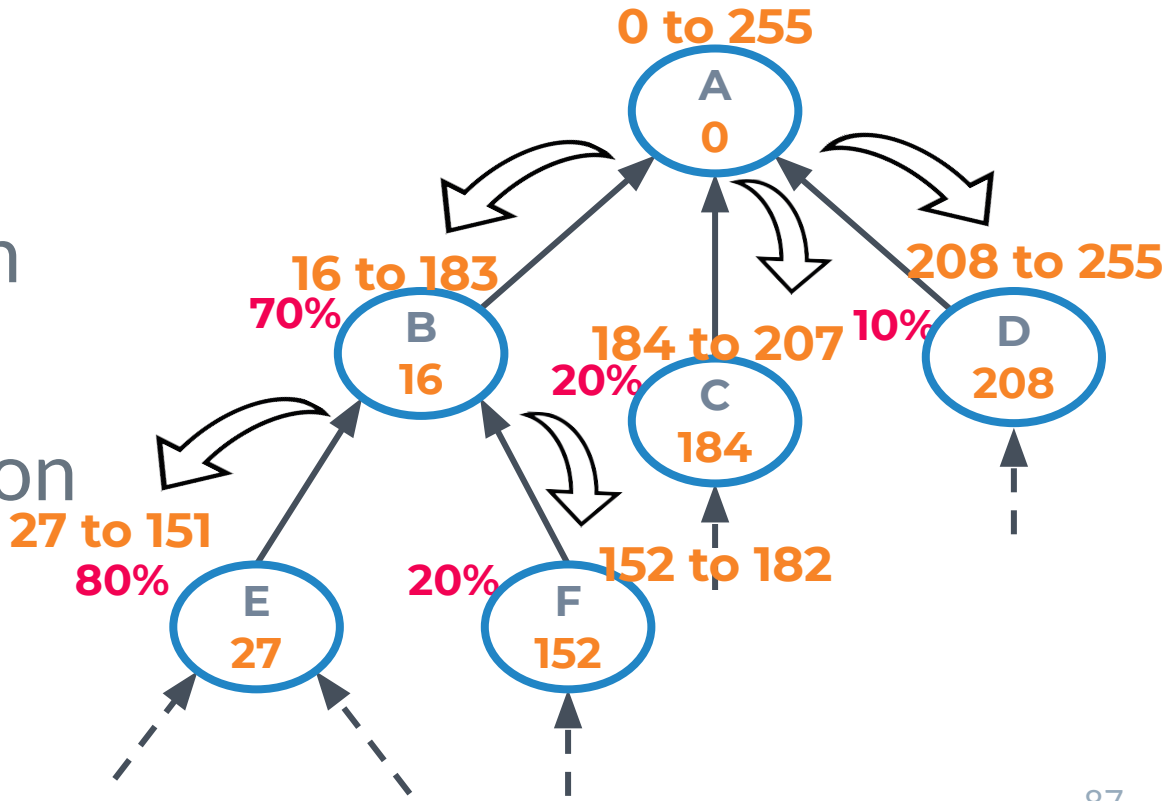


Matrix: Complexity Analysis

- Message overhead
  - $Msg(Matrix^{IP}(Ctree, r)) = \Theta(n)$

- Time
  - $Time(Matrix^{IP}(Ctree, r)) = \Theta(depth(Ctree))$

Matrix Evaluation

Parameters	Values
Base Station	1 Center
Number of nodes	100
Radio Range (m)	100
Density (nodes/m^2)	10
Number of experiments	10
Path Loss Exponent	4.7
Power decay (dB)	55.4
Shadowing Std Dev (dB)	3.2
Simulation duration (min)	20
Application messages (per node)	10
Max. Routing table size	20

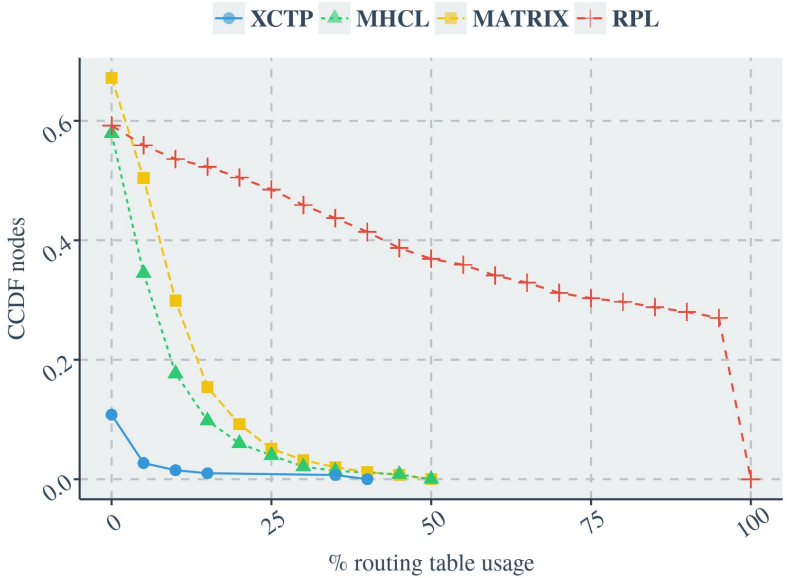
Matrix Evaluation

Parameters	Values
Base Station	1 Center
Number of nodes	100
Radio Range (m)	100
Density (nodes/m^2)	10

Faulty scn.	Short dur.	Mod. dur.	Long Dur.
Low prob.	(1%, 10s)	(1%, 20s)	(1%, 40s)
Mod. prob.	(5%, 10s)	(5%, 20s)	(5%, 40s)
High prob.	(15%, 10s)	(15%, 20s)	(15%, 40s)

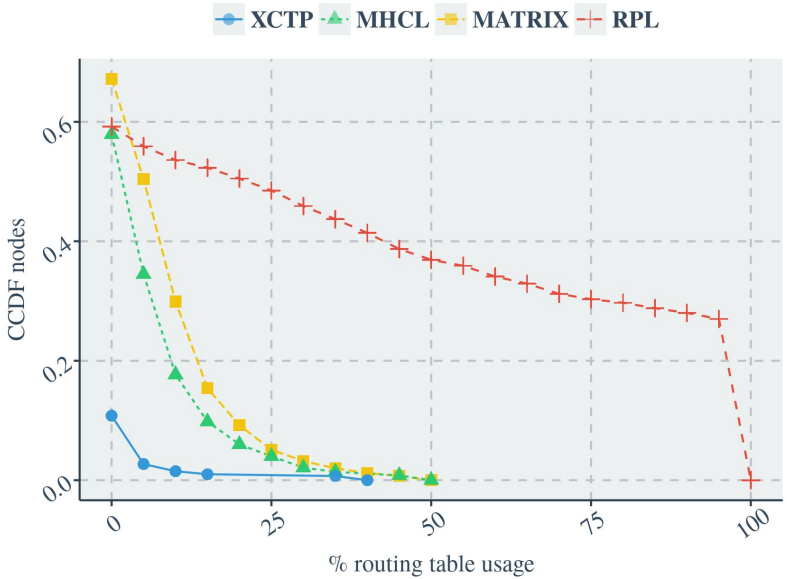
Matrix Evaluation: Reverse routing

- Some RPL nodes uses 100% of available route entries

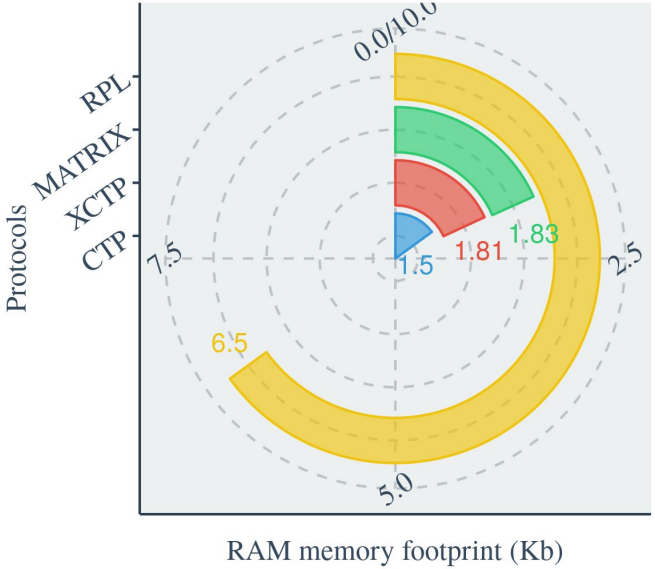


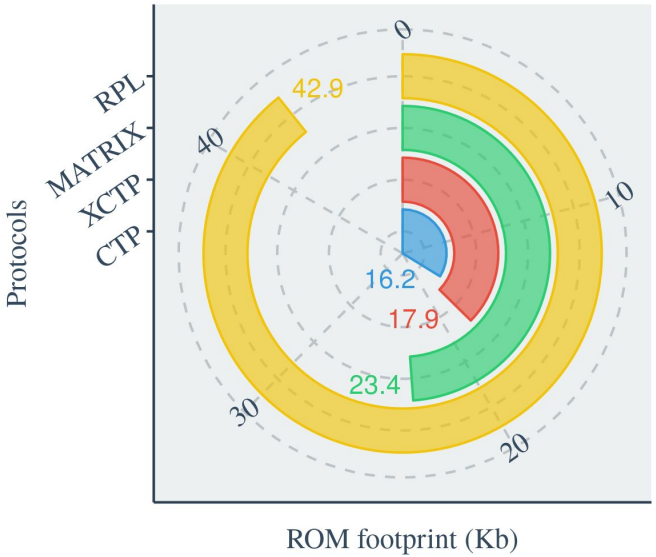
Matrix Evaluation: Reverse routing

- Some RPL nodes uses 100% of available route entries
- Matrix and MHCL are close one each other
- XCTP uses reverse entries on demand

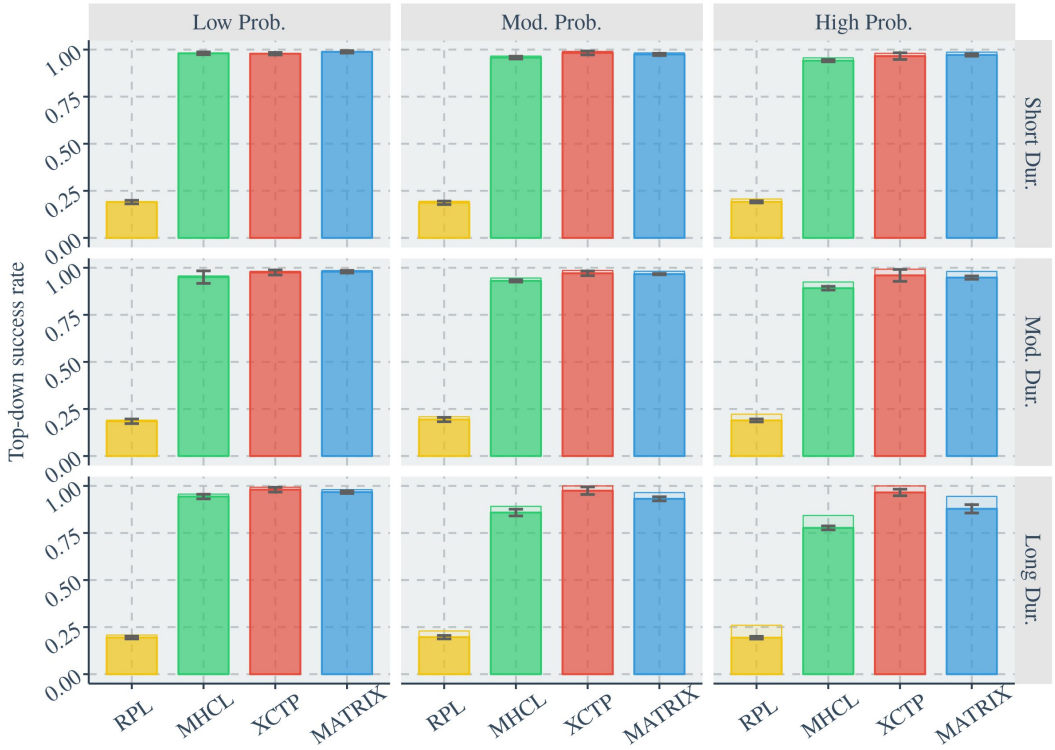


Matrix Evaluation: Memory Footprint



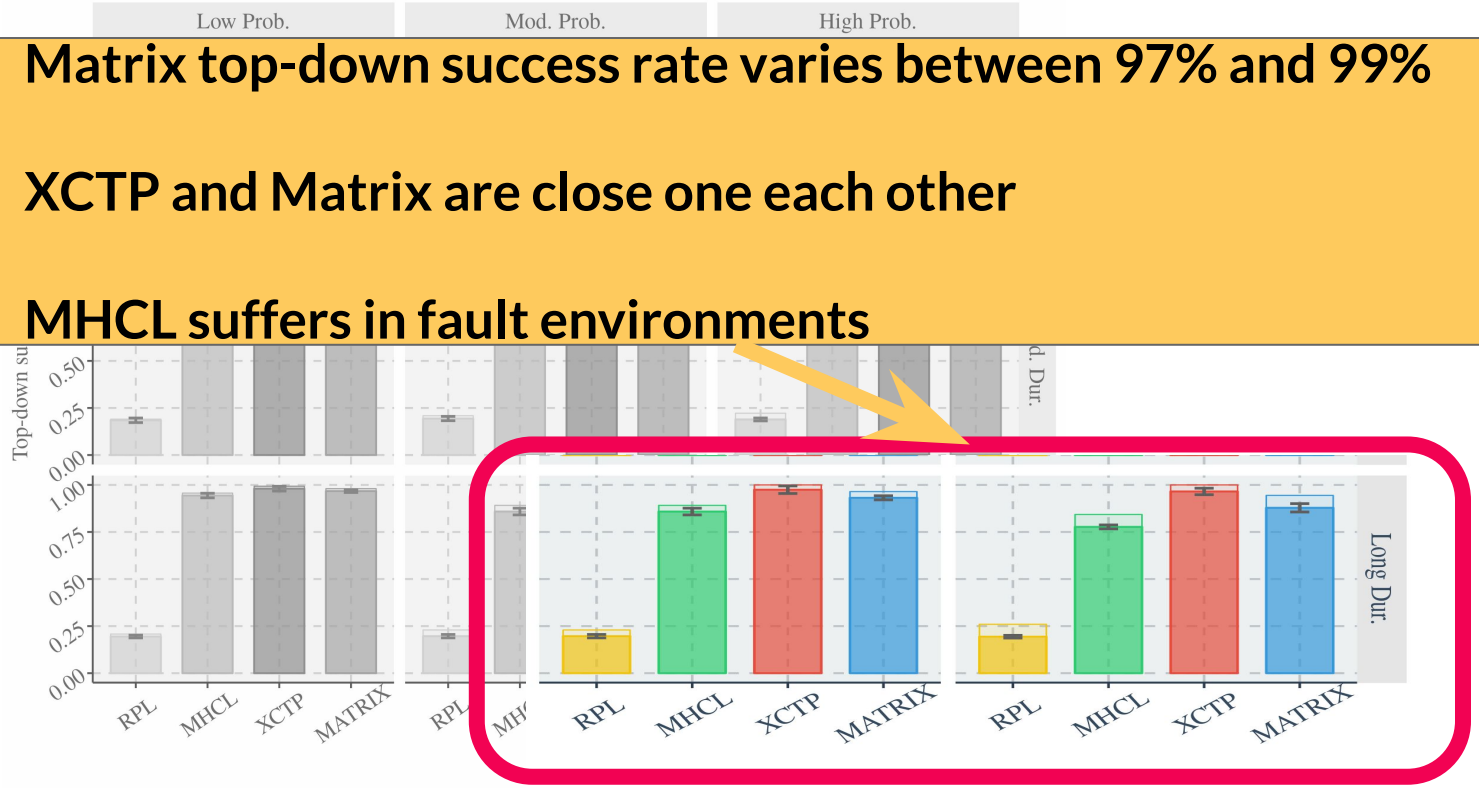


Matrix Evaluation: Top-down delivery

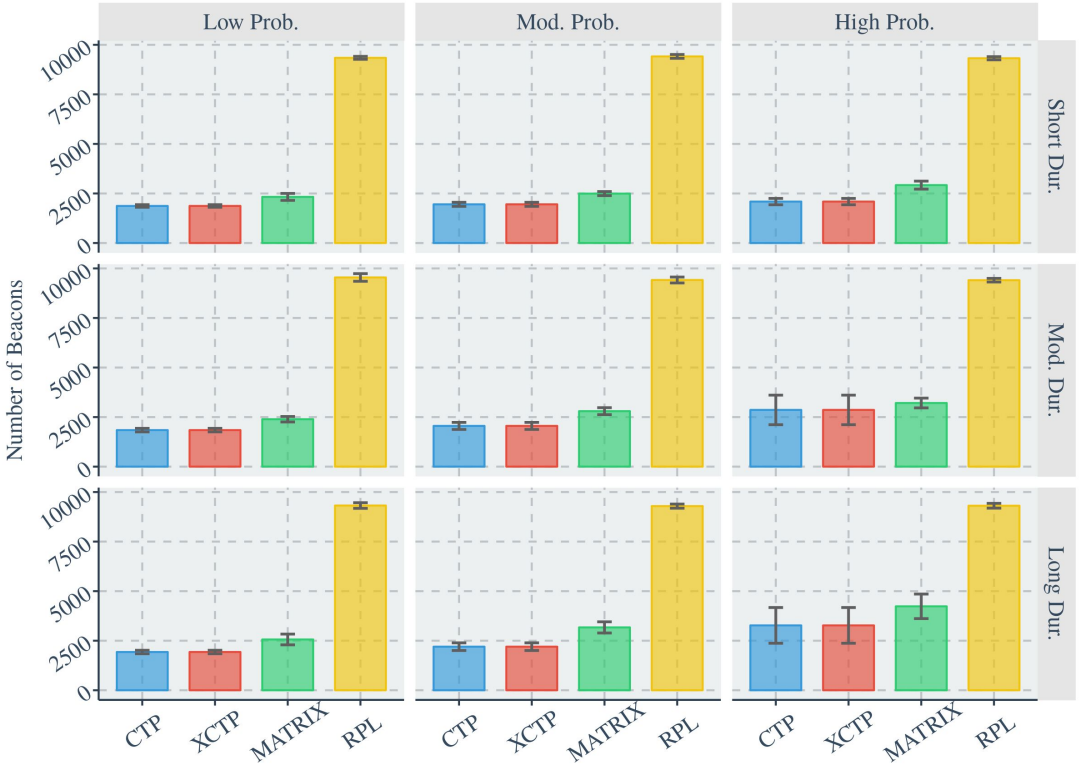


Matrix Evaluation: Top-down delivery

- ✓ Matrix top-down success rate varies between 97% and 99%
- ✓ XCTP and Matrix are close one each other
- ✓ MHCL suffers in fault environments

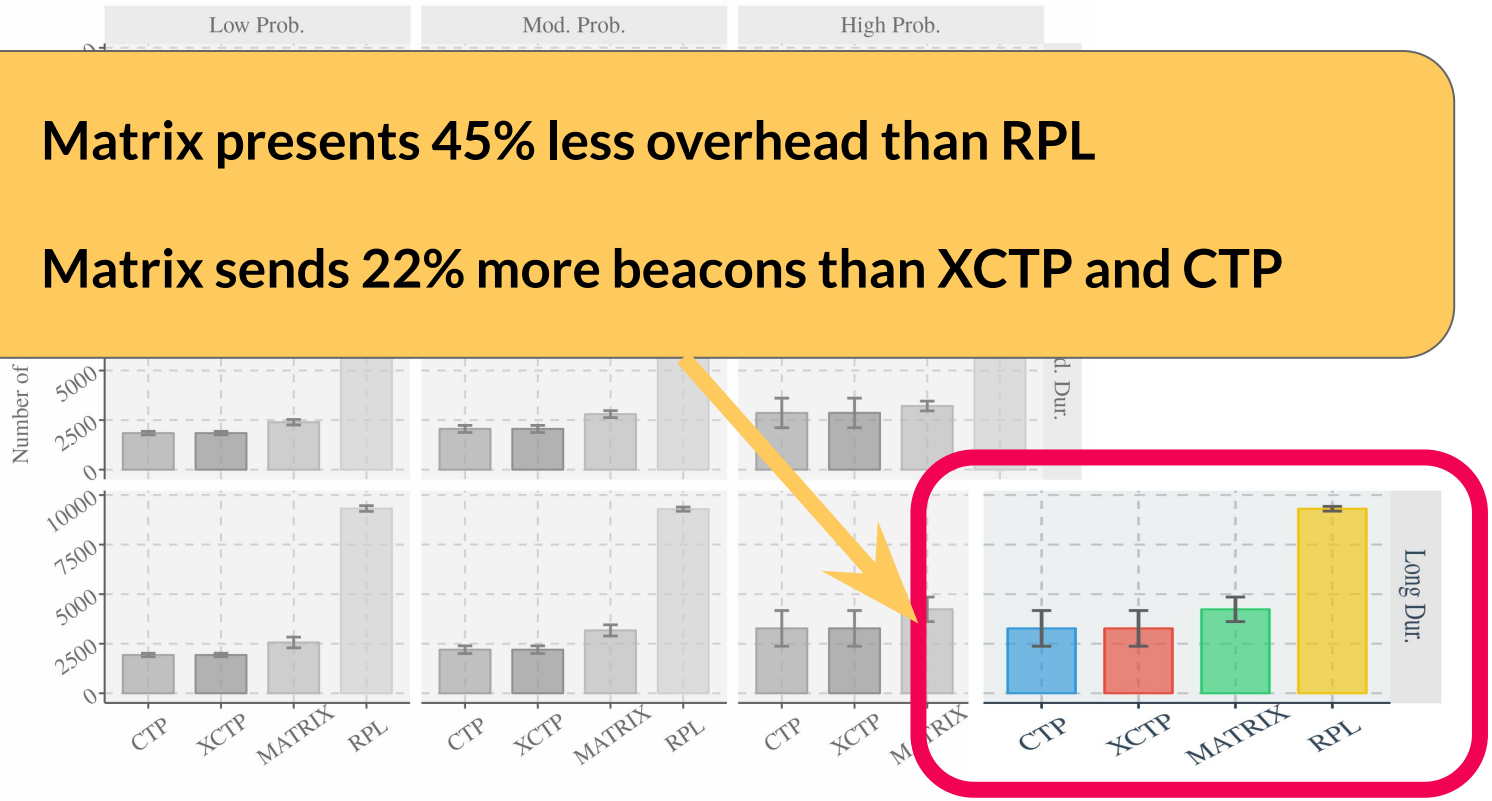


Matrix Evaluation: Control Overhead



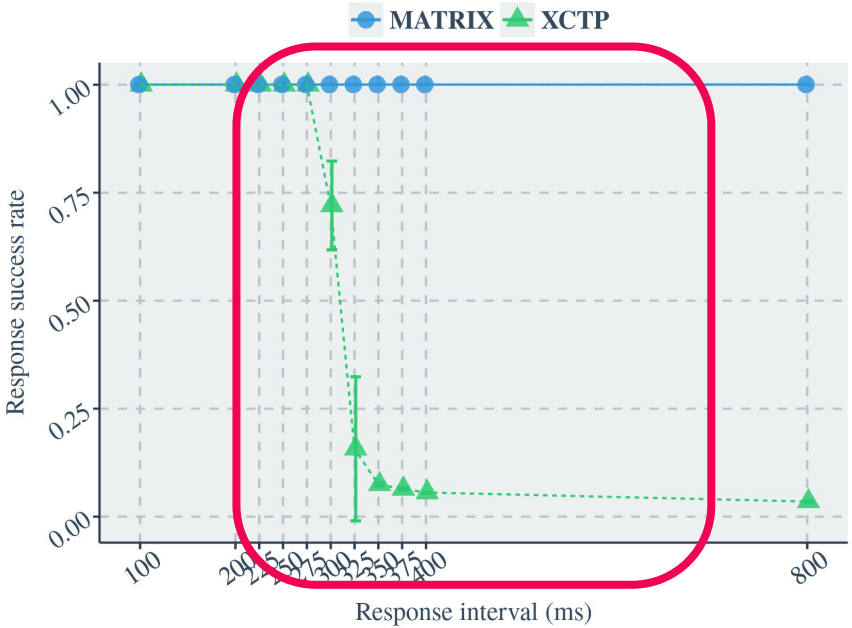
Matrix Evaluation: Control Overhead

- ✓ **Matrix presents 45% less overhead than RPL**
- ✓ **Matrix sends 22% more beacons than XCTP and CTP**

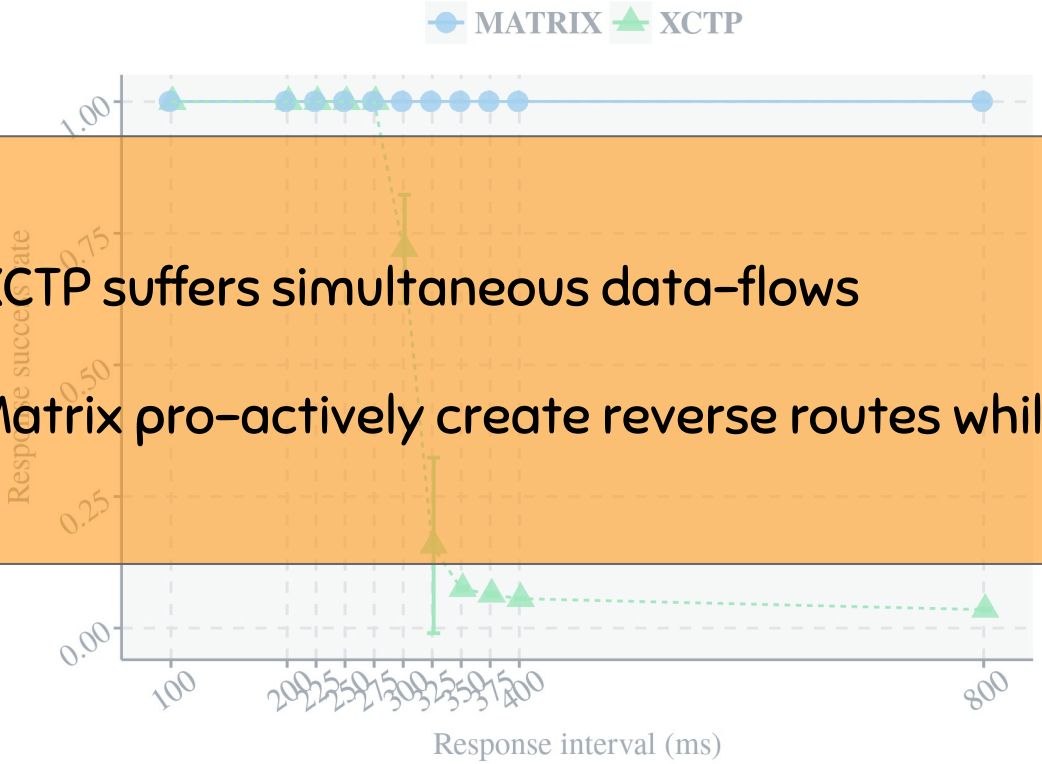


Matrix Evaluation: On-demand vs Pro-active

✓ **MATRIX is not sensitive to delayed data flows as XCTP**



Matrix Evaluation: On-demand vs Pro-active



- ✓ XCTP suffers simultaneous data-flows
- ✓ Matrix pro-actively create reverse routes while XCTP does not.

Reports

1. **Matrix: Multihop Address allocation and dynamic any-To-any Routing for 6LoWPAN.**

   ACM MSWiM 2016
2. **Matrix: Multihop Address allocation and dynamic any-To-any Routing for 6LoWPAN.**

   Computer Networks 2018

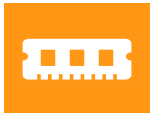
4.

An Alternative Routing Protocol for Mobile IoT

- ✓ Mobile Matrix (μMatrix)
- ✓ Results
- ✓ Reports

Mobile Matrix Approach

Any-to-any routing



Memory efficiency

Reliability

Fault Tolerance

Hardware independence

IoT integration

Mobile Matrix Approach

Mobility Management

Nodes do not ever change its IPv6 address

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Nodes do not ever change its IPv6 address

Adjustable control message overhead

It try to figure out mobility events quickly
in order to perform the handover process

Mobile Matrix Approach

Mobility Management

Nodes do not ever change its IPv6 address

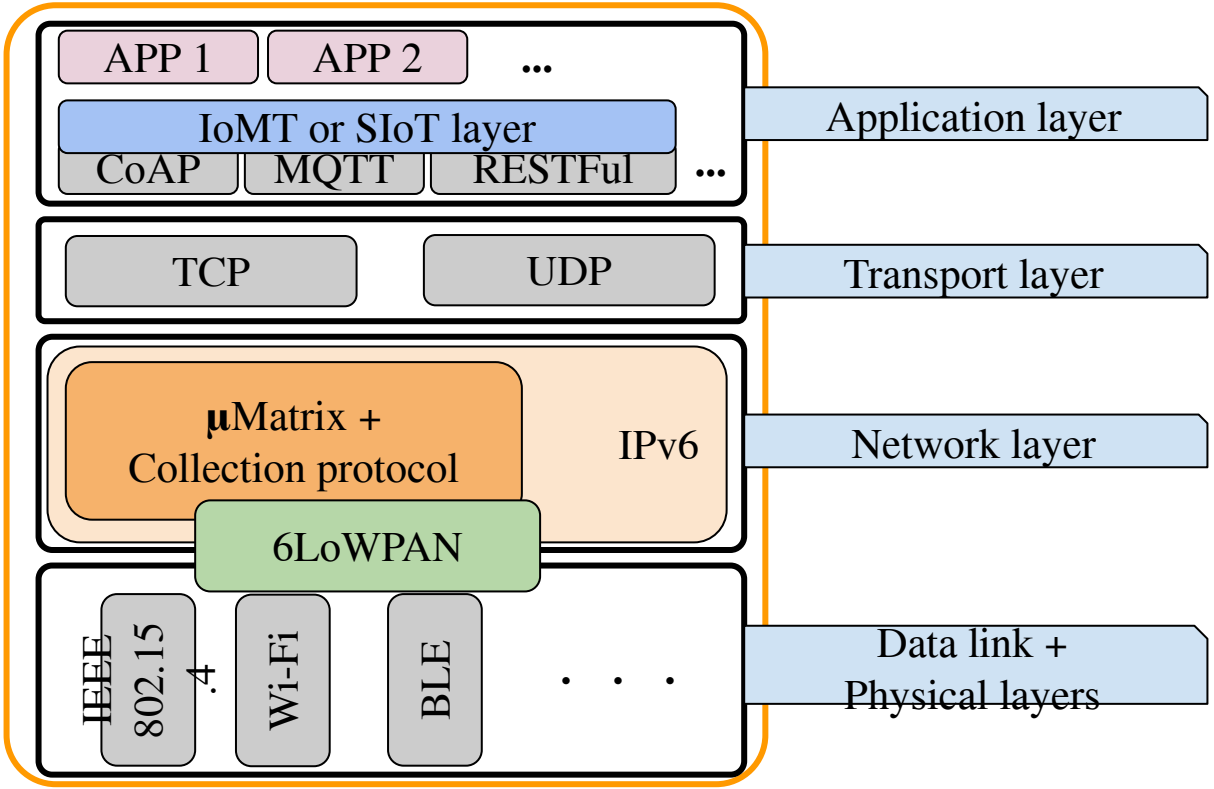
Adjustable control message overhead

It try to figure out mobility events quickly
in order to perform the handover process

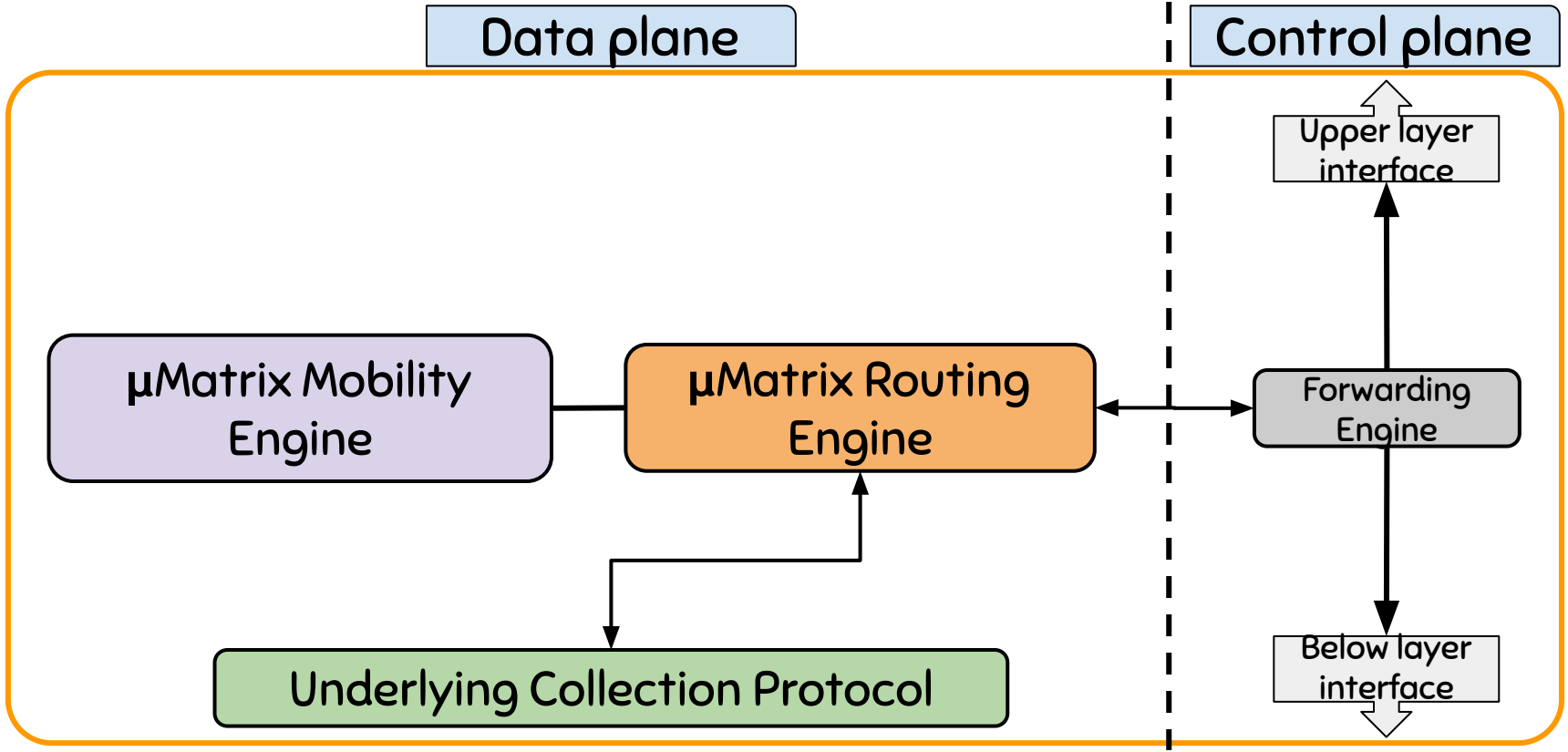
Low memory footprint under mobility

It uses hierarchical address allocation
enhancing memory resource usage

Mobile Matrix's Architecture



Mobile Matrix's Architecture



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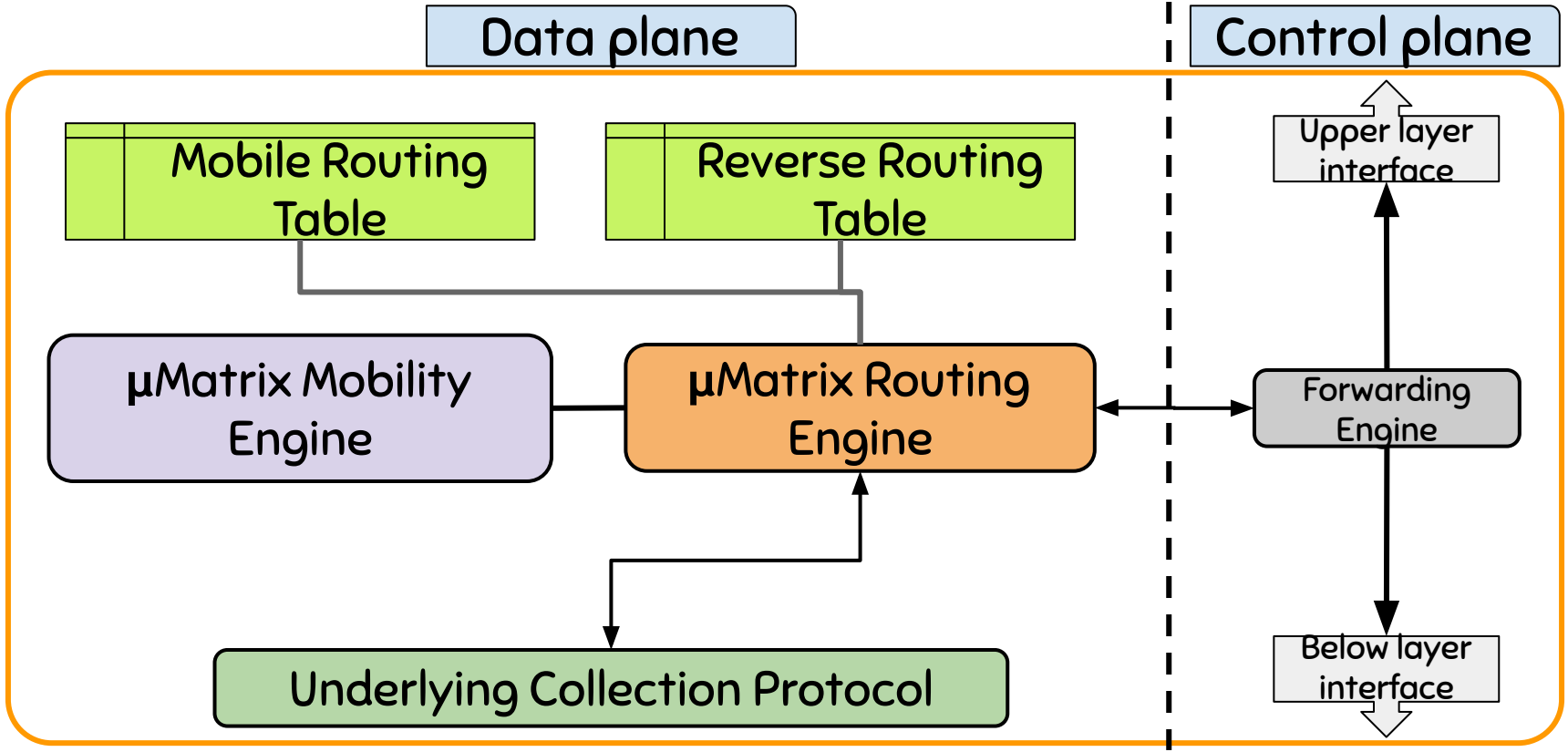
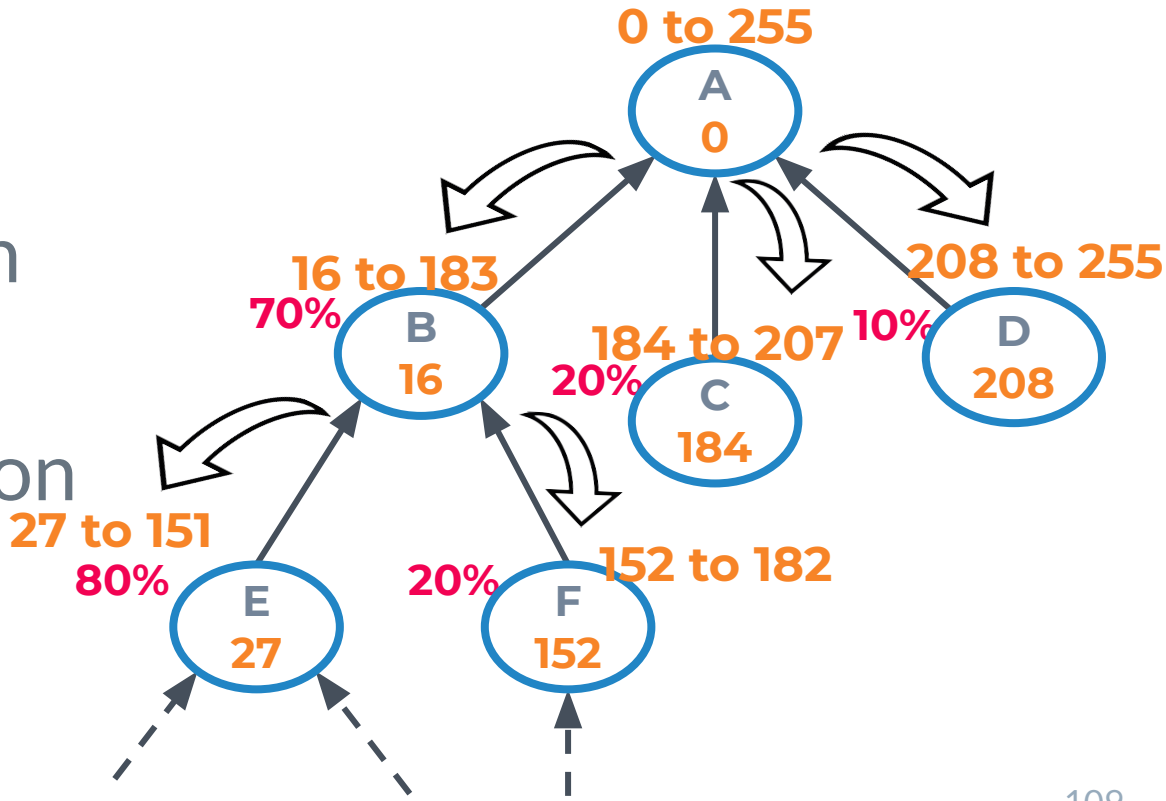


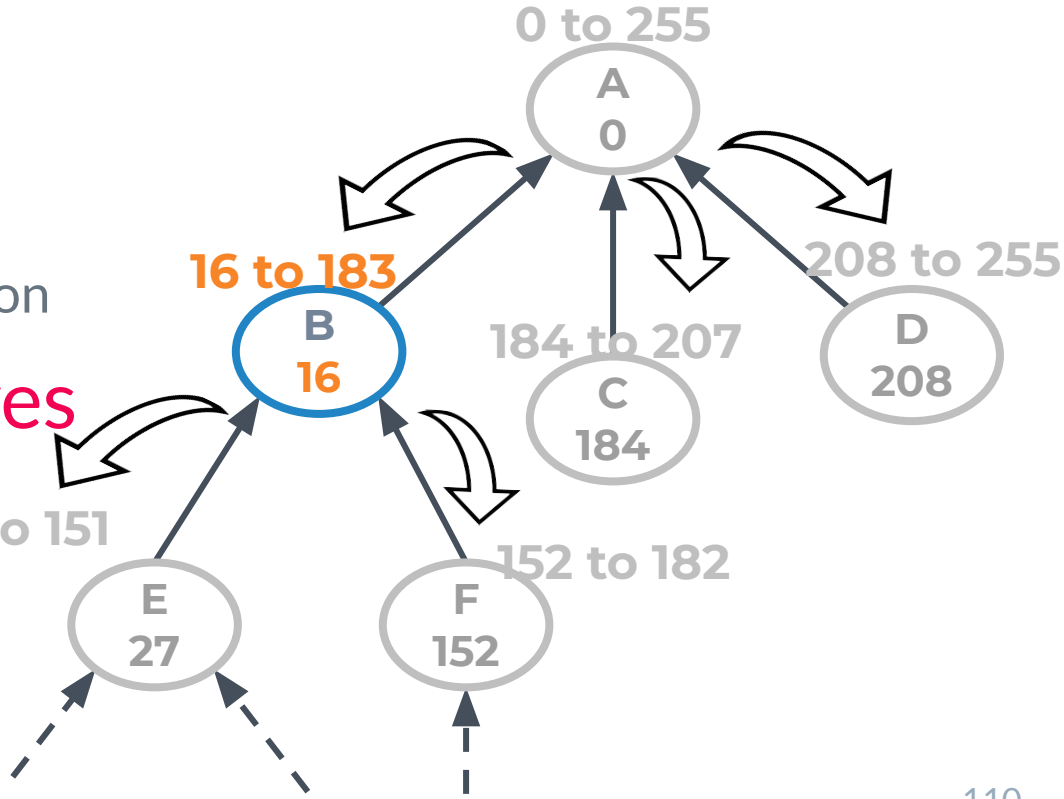
Mobile Matrix design

1. Tree Collection
2. Data aggregation
3. Hierarchical Address Allocation



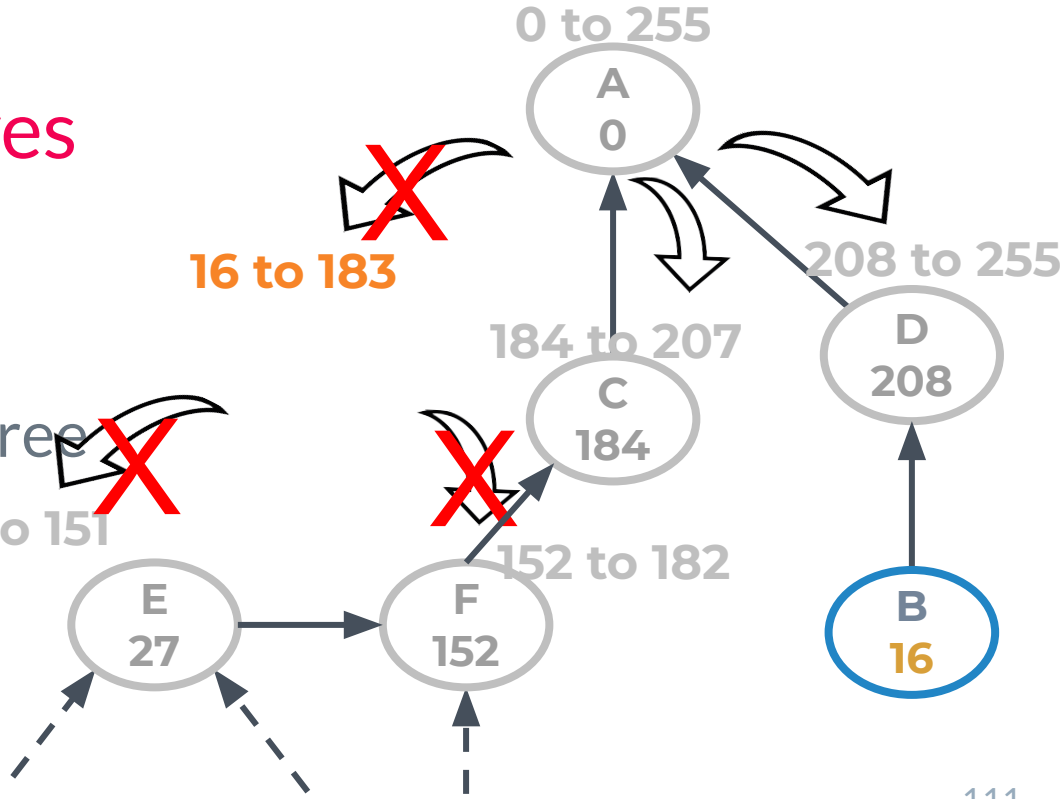
Mobile Matrix design: Mobility management

1. Tree Collection
2. Data aggregation
3. Hierarchical Address Allocation
4. What to do if B moves and the topology changes?



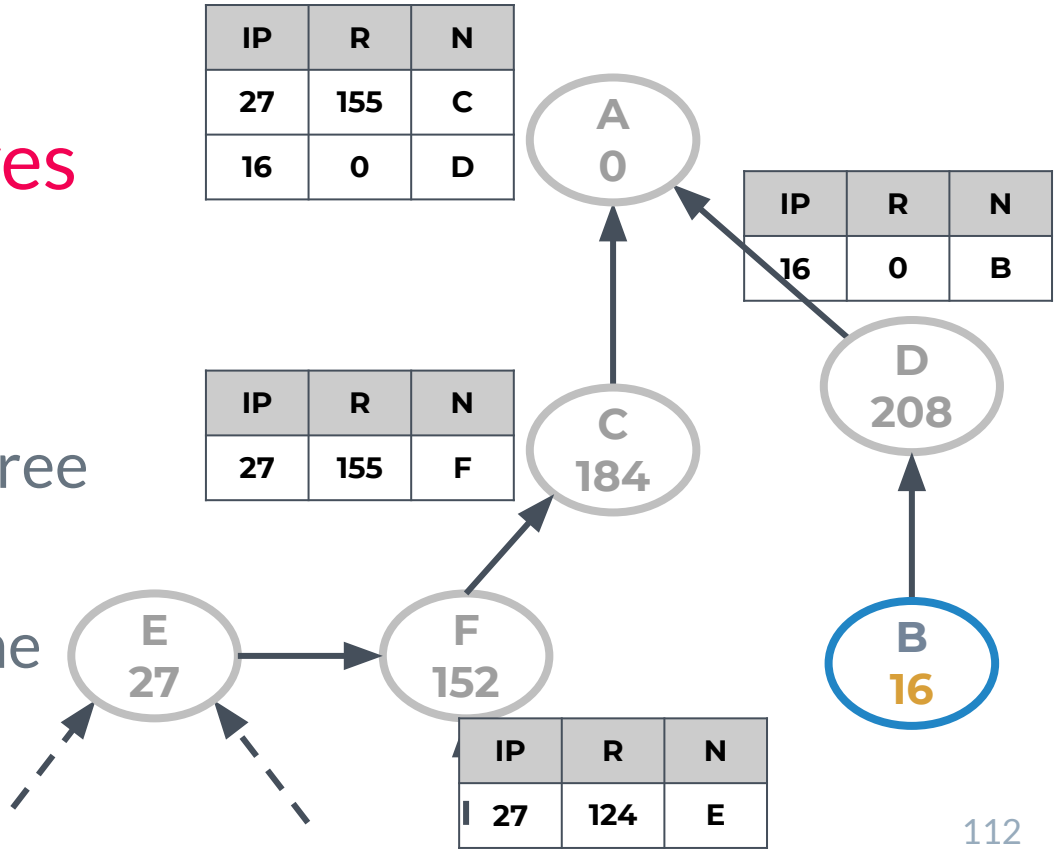
Mobile Matrix design: Mobility management

4. What to do if B moves and the topology changes?
   - The reverse routing tree become outdated

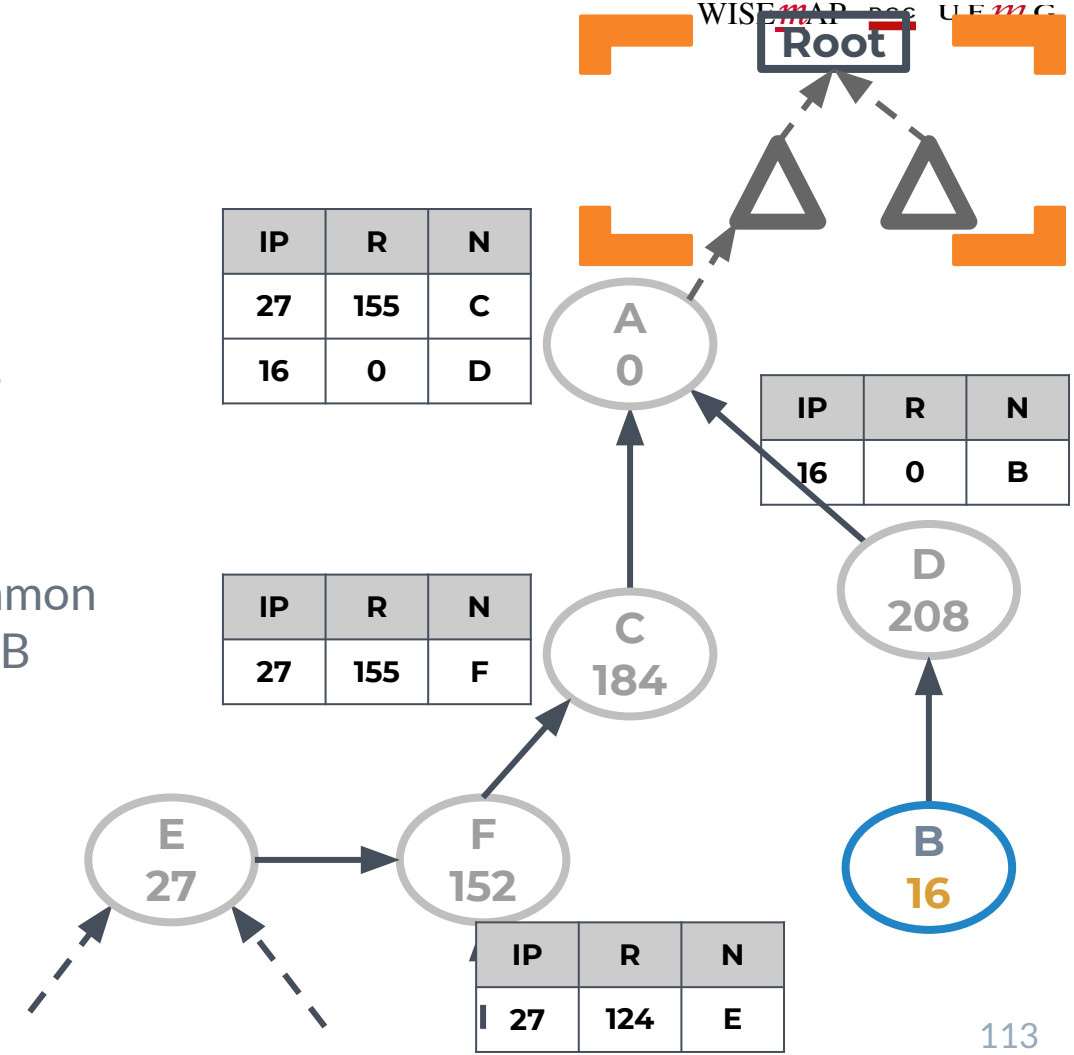


Mobile Matrix design: Mobility management

4. What to do if B moves and the topology changes?
   - The reverse routing tree become outdated
   - μMatrix Mobile engine redo the paths

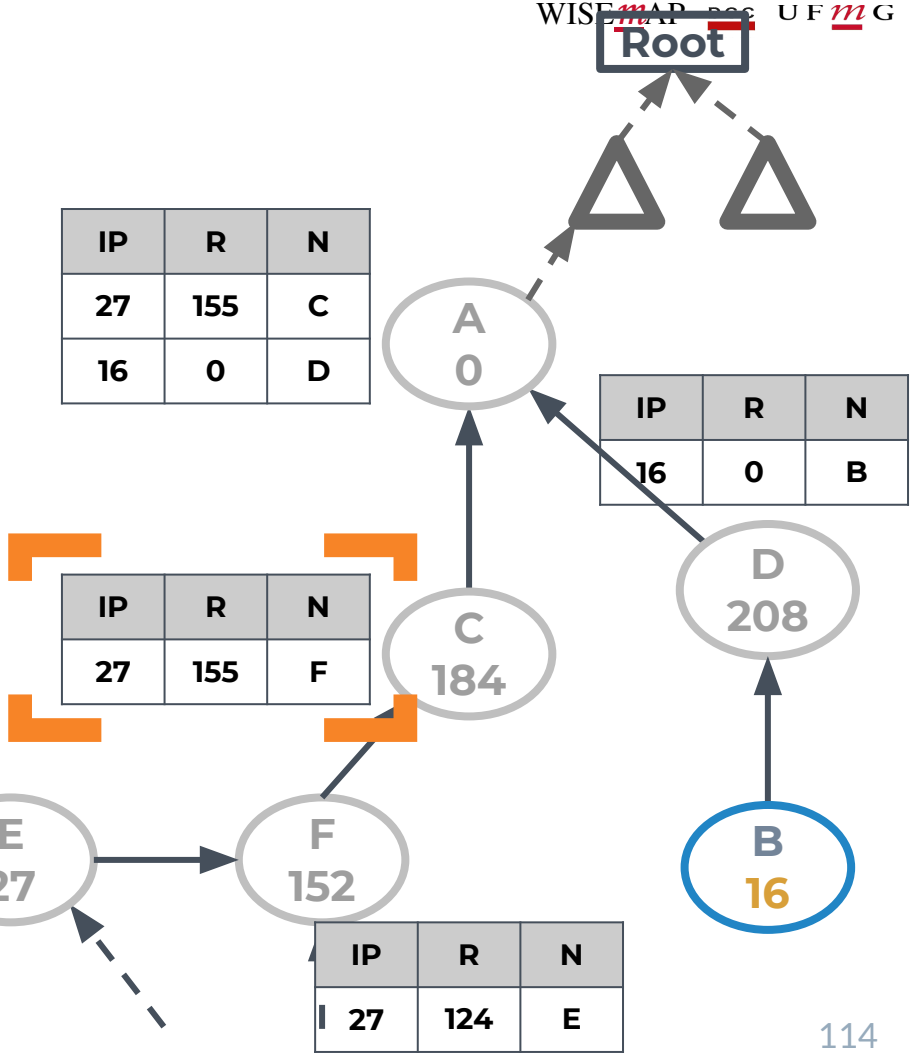


- Local table updates
  - Nodes
    - From B to A
      - A is the Least Common Ancestor (LCA) of B
  - From E/F to A

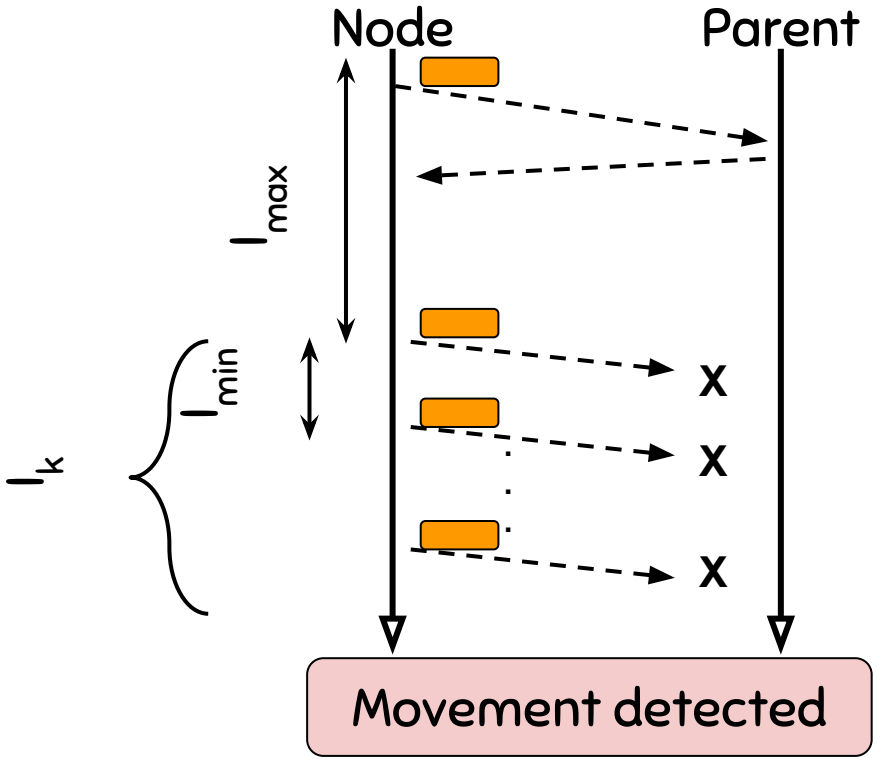


- Local table updates
  - Nodes
    - From B to A
      - A is the Least Common Ancestor (LCA) of B
  - From E/F to A

- We only need 1 entry IP for contiguous IP



Mobile Matrix design: Handling Mobility



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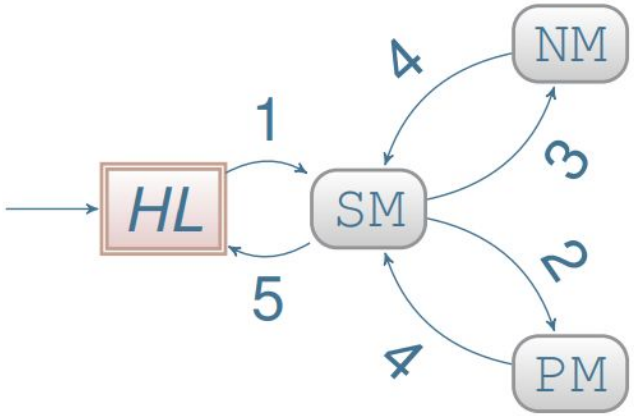
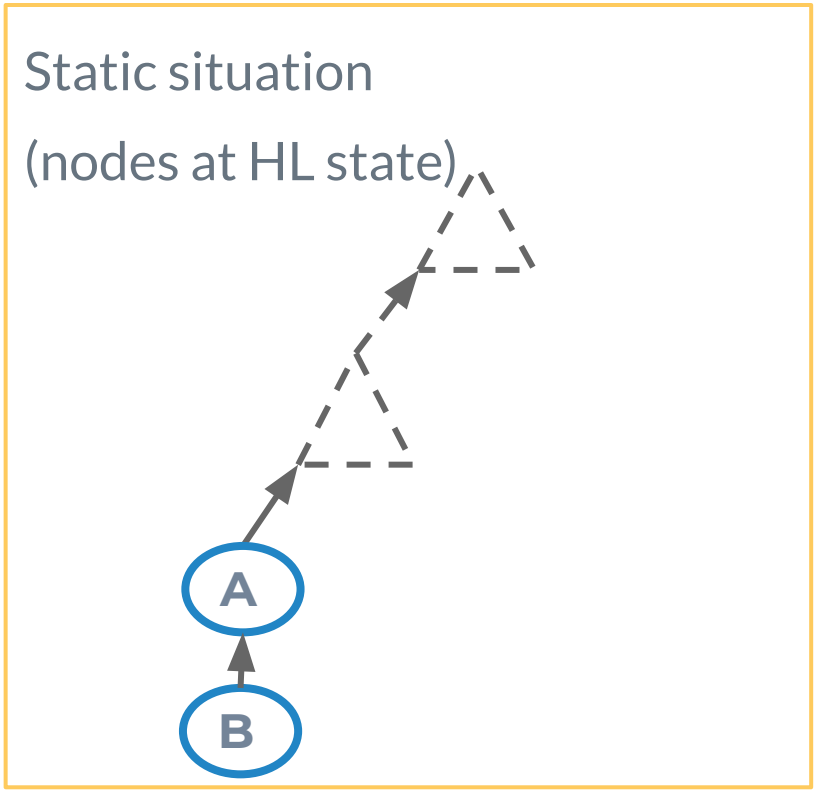


HL	Home Location
SM	Someone Moved
NM	Node Moves
PM	Parent Moves
1	IPparent does not answer
2	Children are active
3	Children are NOT active
4	CTparent does not answer
5	IPparent is back

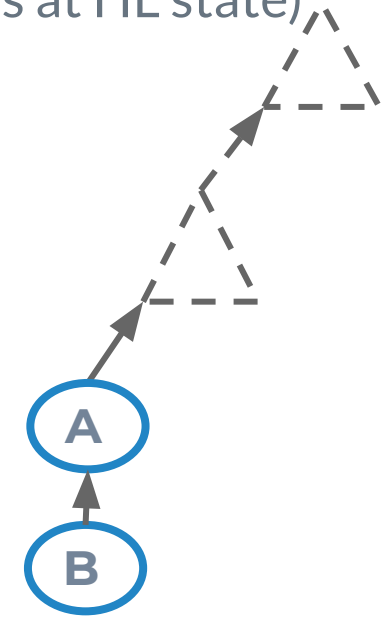
Mobile Matrix design: Handling Mobility



Mobile Matrix design: Handling Mobility

Static situation

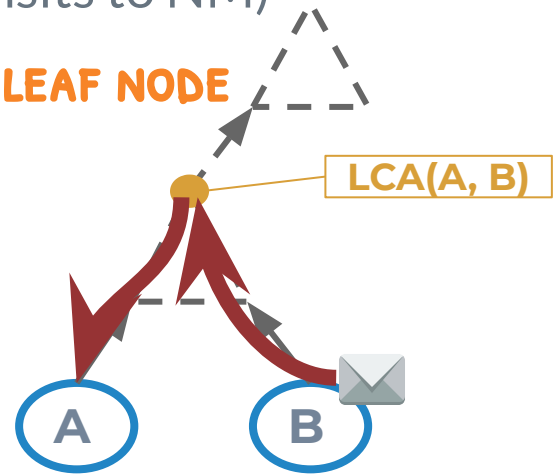
(nodes at HL state)



B moves

(B transits to NM)

B IS A LEAF NODE



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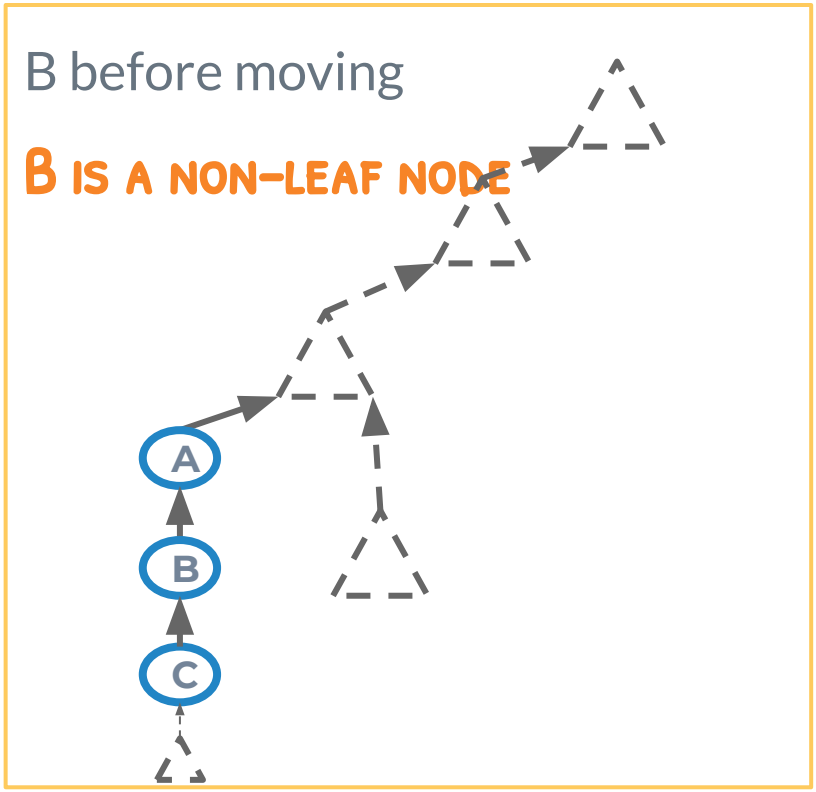

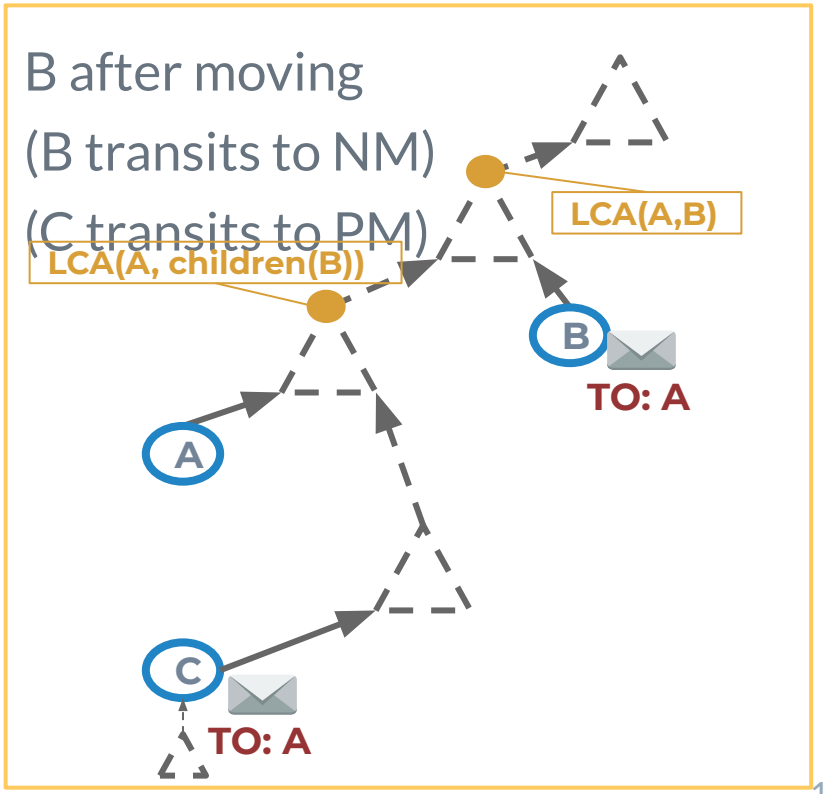

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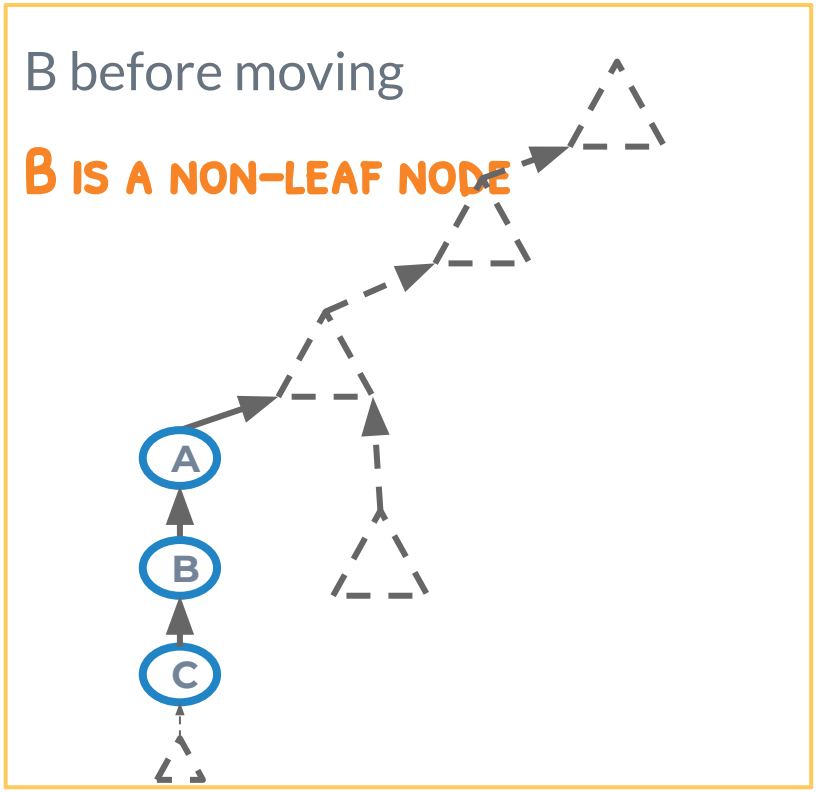

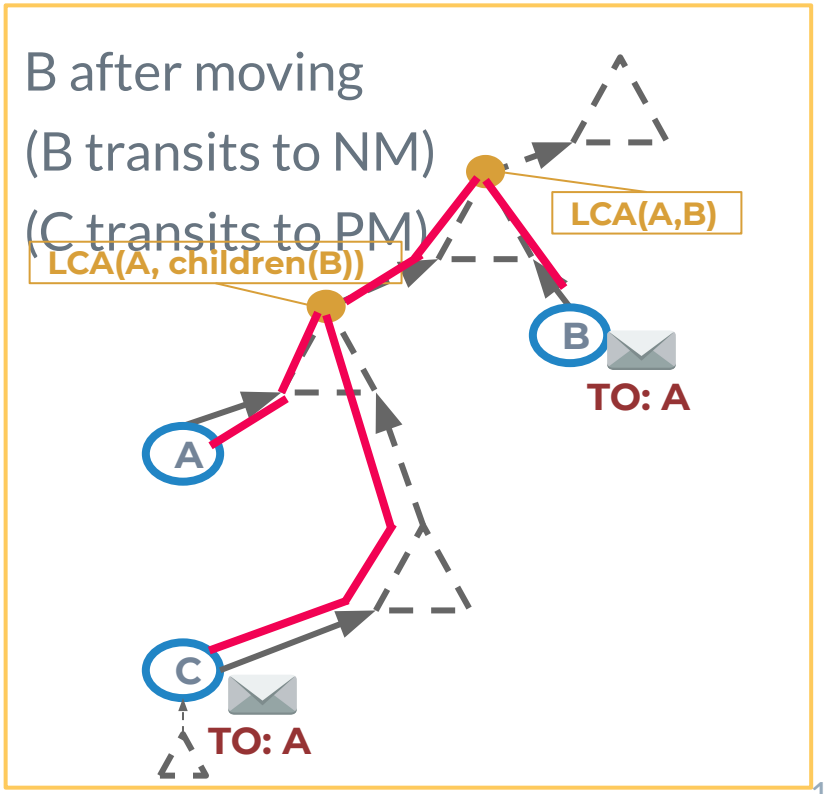

Mobile Matrix design: Complexity analysis

- The memory footprint to manage the mobility of one node μMatrix is
  - M(u) = O(depth(Ctree))

Collection Tree

Mobile Matrix design: Complexity analysis

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Collection Tree

- The control message complexity of μMatrix to perform routing under mobility is
  - Msg(μMatrix) = Msg(μMatrix^{hM}) + Msg(μMatrix^{kR})

Mobility detection cost

Route rebuild cost

Mobile Matrix design: Complexity analysis

- The memory footprint to manage the mobility of one node μMatrix is
  - M(u) = O(depth(Ctree))

COLLECTION TREE

- The control message complexity of μMatrix to perform routing under mobility is

$$O\left(\frac{\log_2 I_k}{I_{min}} + \frac{m}{I_{max}}\right) + O\left(\frac{m \times \Delta}{\delta} depth(Ctree)\right)$$

MOBILITY DETECTION COST

ROUTE REBUILD COST

  - Msg(μMatrix) =

M, N – MOBILE AND STATIC NODES RESPECTIVELY,
Δ – TIME AWAY FROM HOME LOCATION.
δ – REVERSE TRICKLE PARAM.

Mobile Matrix evaluation

Group Regularity Mobility Model

GRM Parameters	Info06	Camb.	MIT
# nodes	78	54	100
Dur. (days)	3	11	15
Group dur. (h)	12	24	720
Dim (m^2)	300	500	1000

Cyclical Random WayPoint Model

CWRP Parameters	Values		
# nodes	100 grid		
Dur. (h)	1.5		
Dim (m^2)	400		
Speed	4 m/s		
Pause	300 s		
# Stops	Uniform (1,5)		
Trace name	**Low**	**Mod.**	**High**
	5%	10%	15%

Mobile Matrix evaluation

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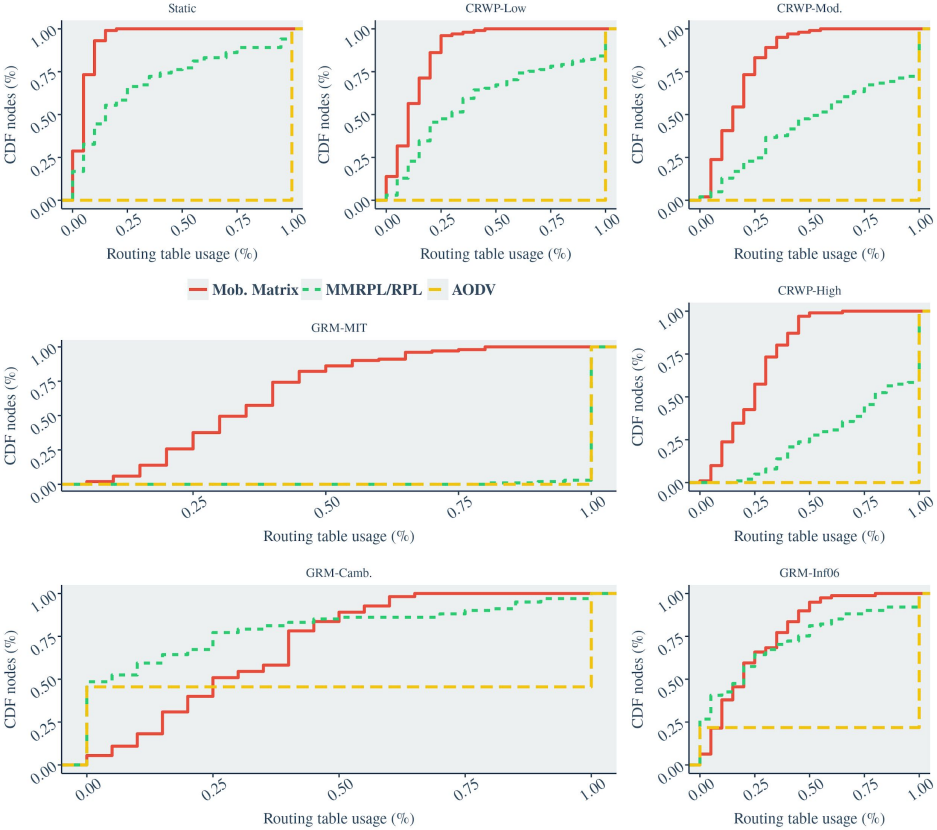
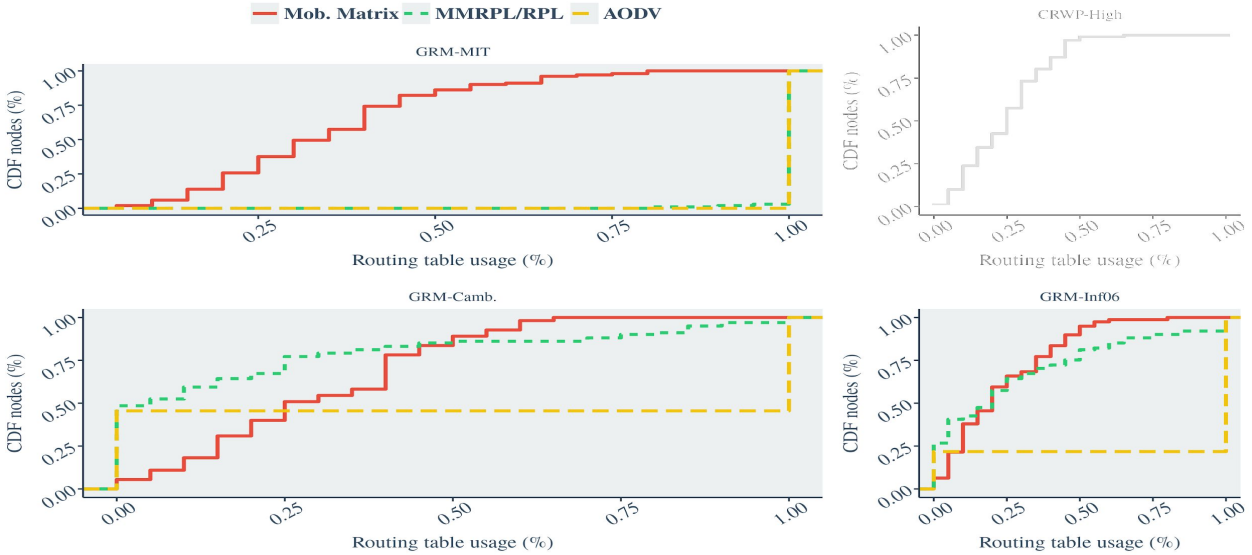
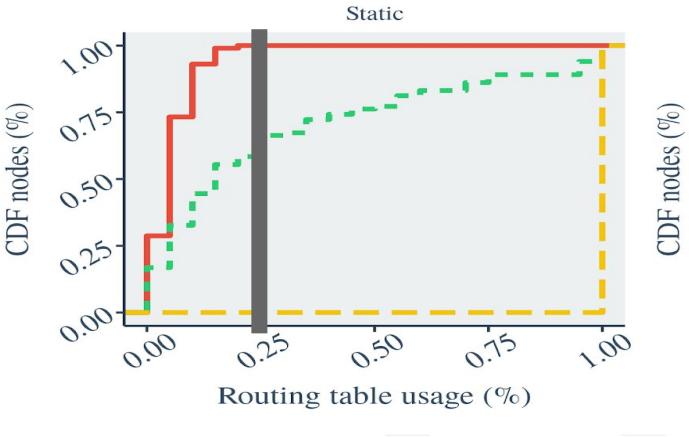


µMatrix Evaluation: Reverse Routing

✓ µMatrix presents lower downward routing table than RPL/MMRPL and AODV

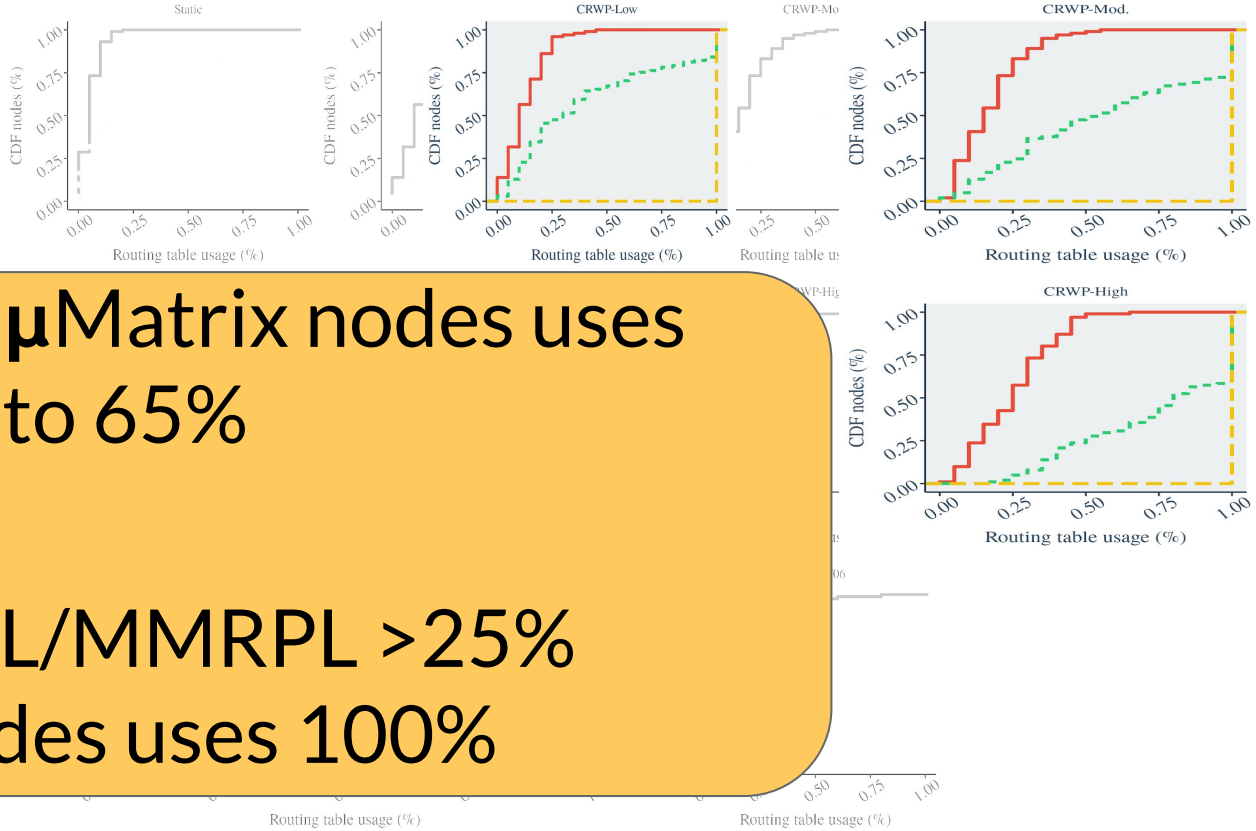


µMatrix Evaluation: Reverse Routing



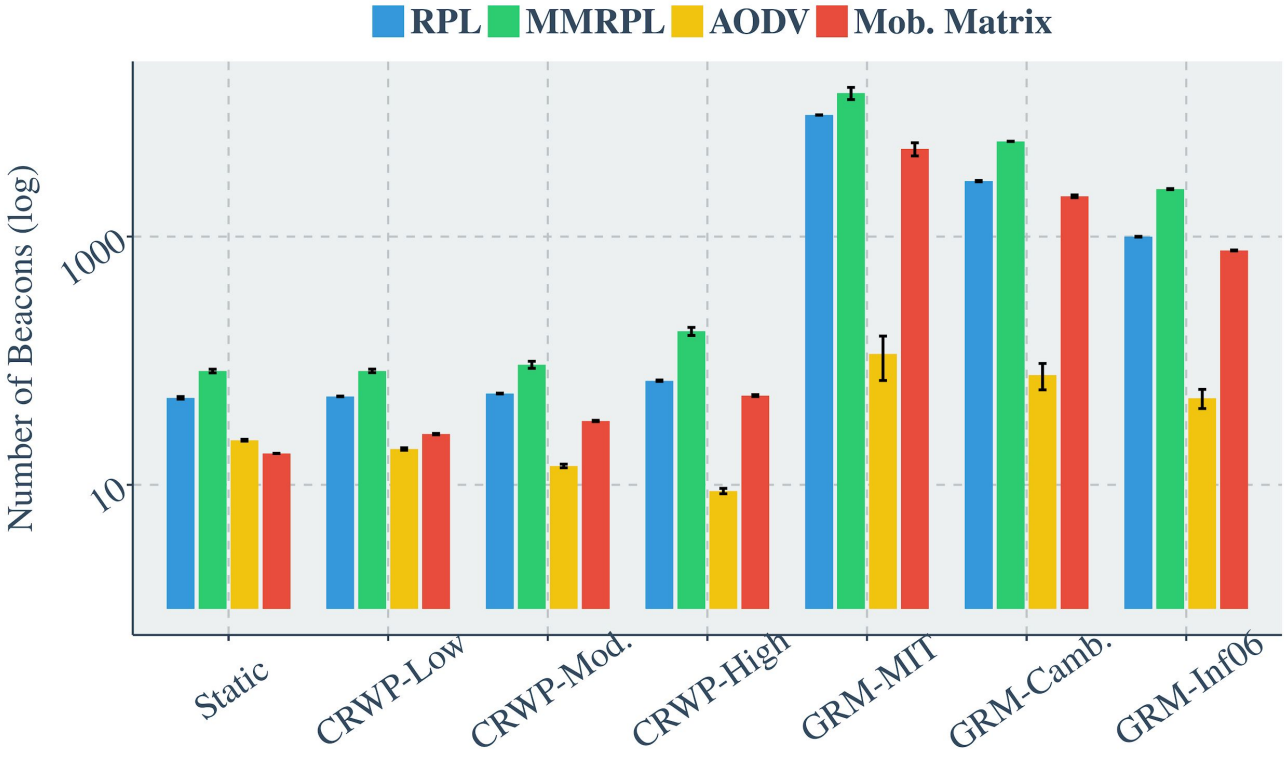
- ✓ All µMatrix nodes uses up to 25%
- ✓ RPL/MMRPL at least 40% nodes uses ≥ 25%

µMatrix Evaluation: Reverse Routing

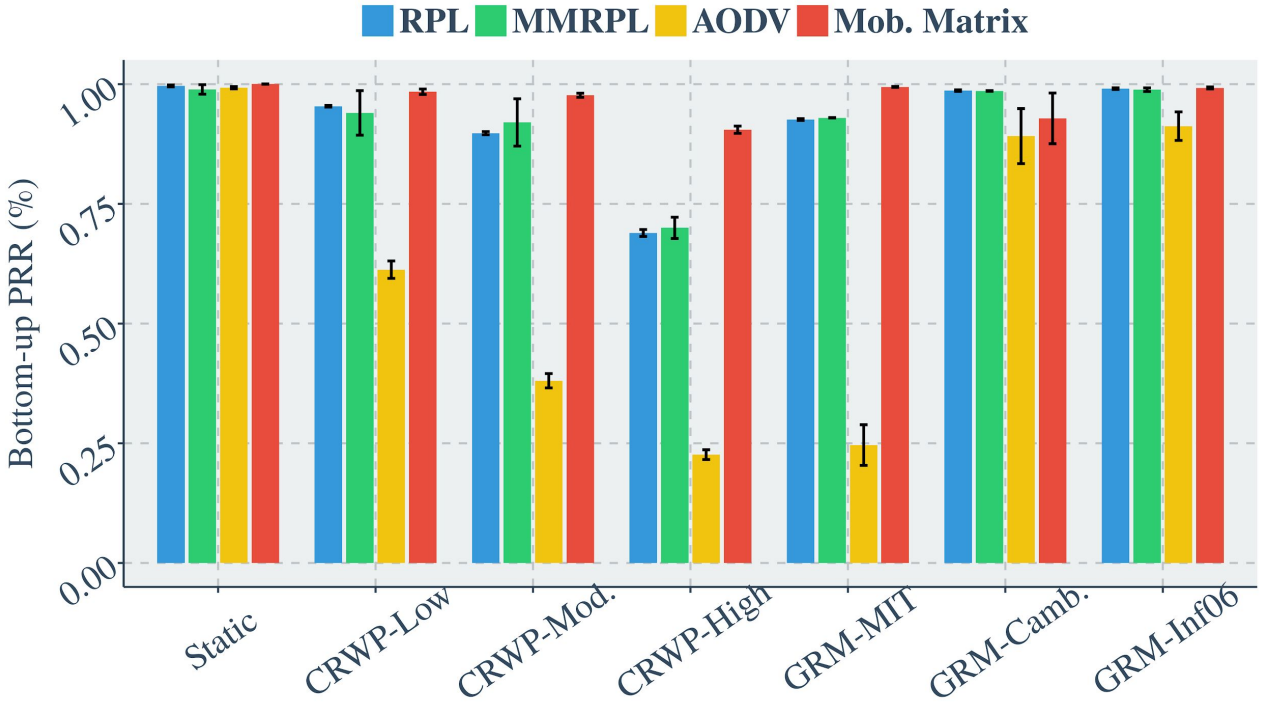


- ✓ All µMatrix nodes uses up to 65%
- ✓ RPL/MMRPL >25% nodes uses 100%

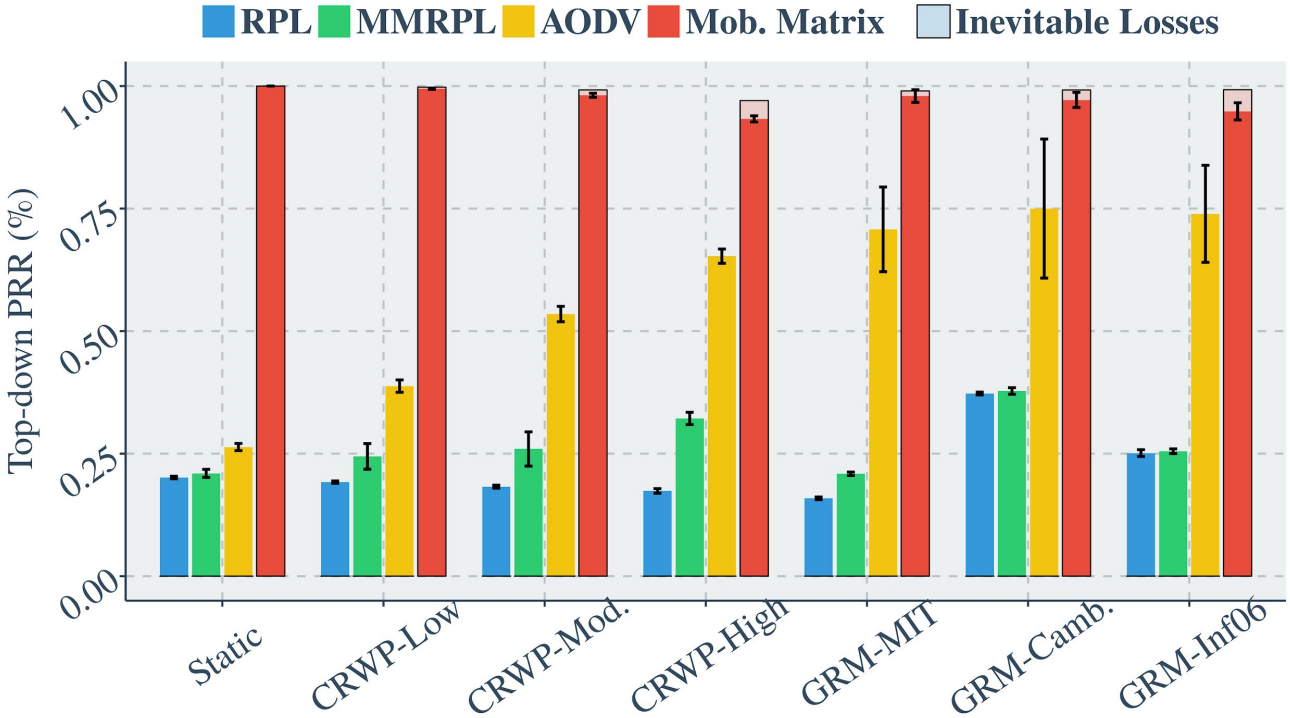
µMatrix Evaluation: Control Overhead



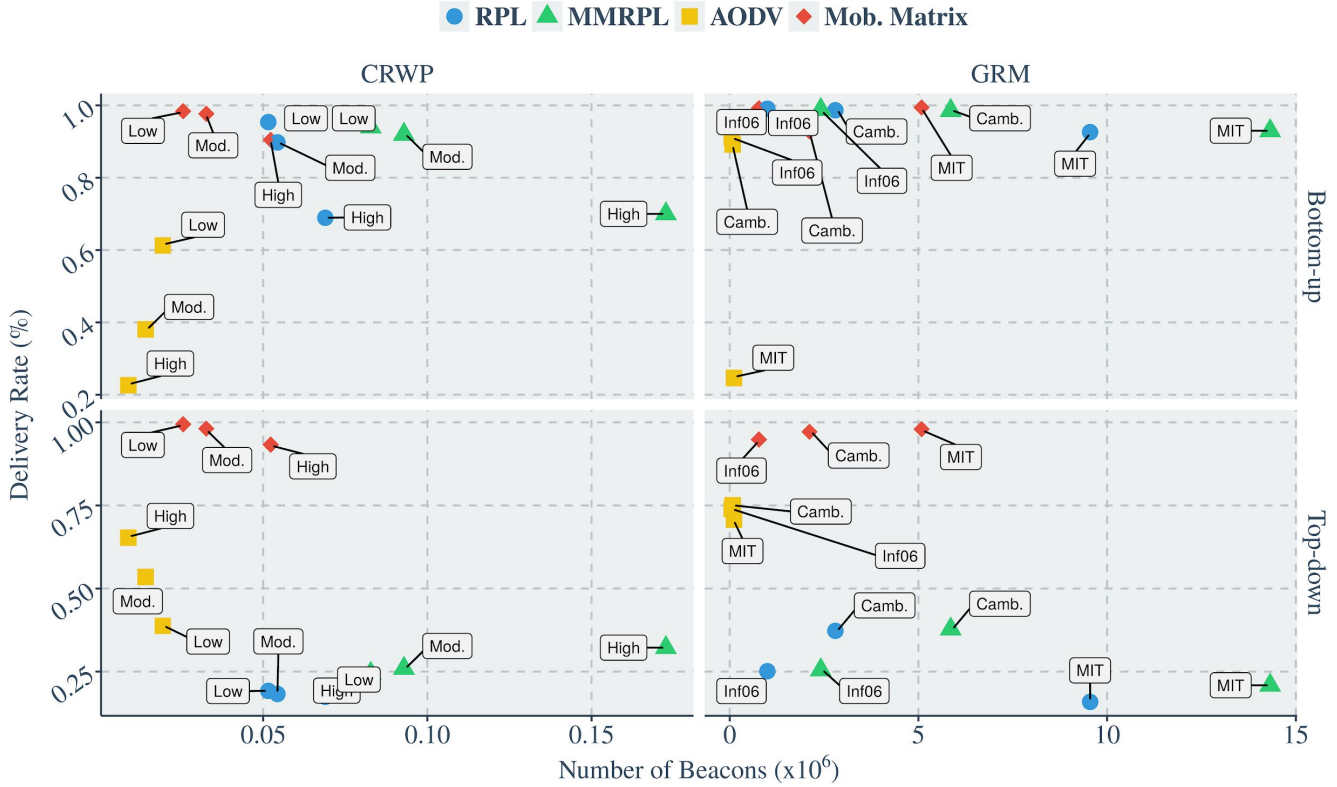
µMatrix Evaluation: Bottom-up delivery



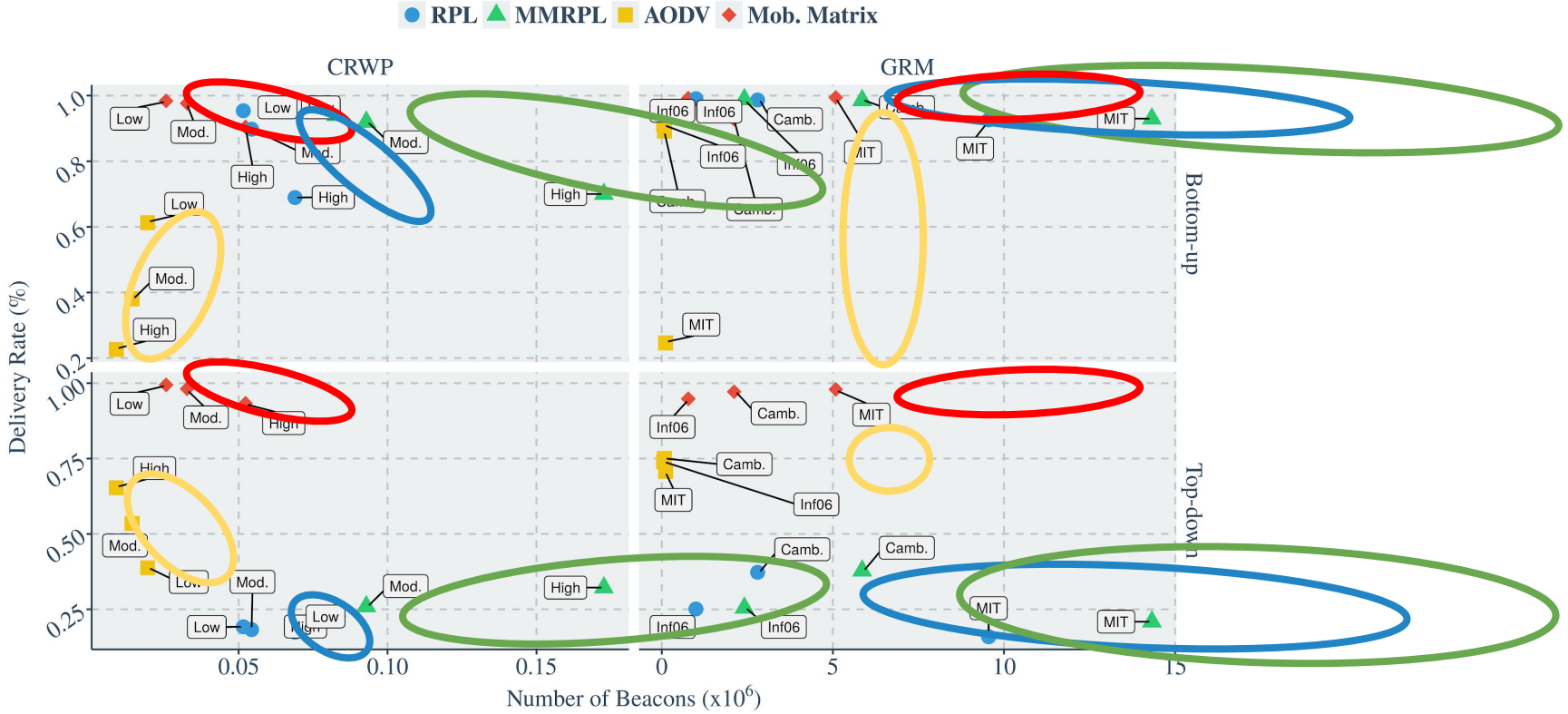
µMatrix Evaluation: Top-down delivery



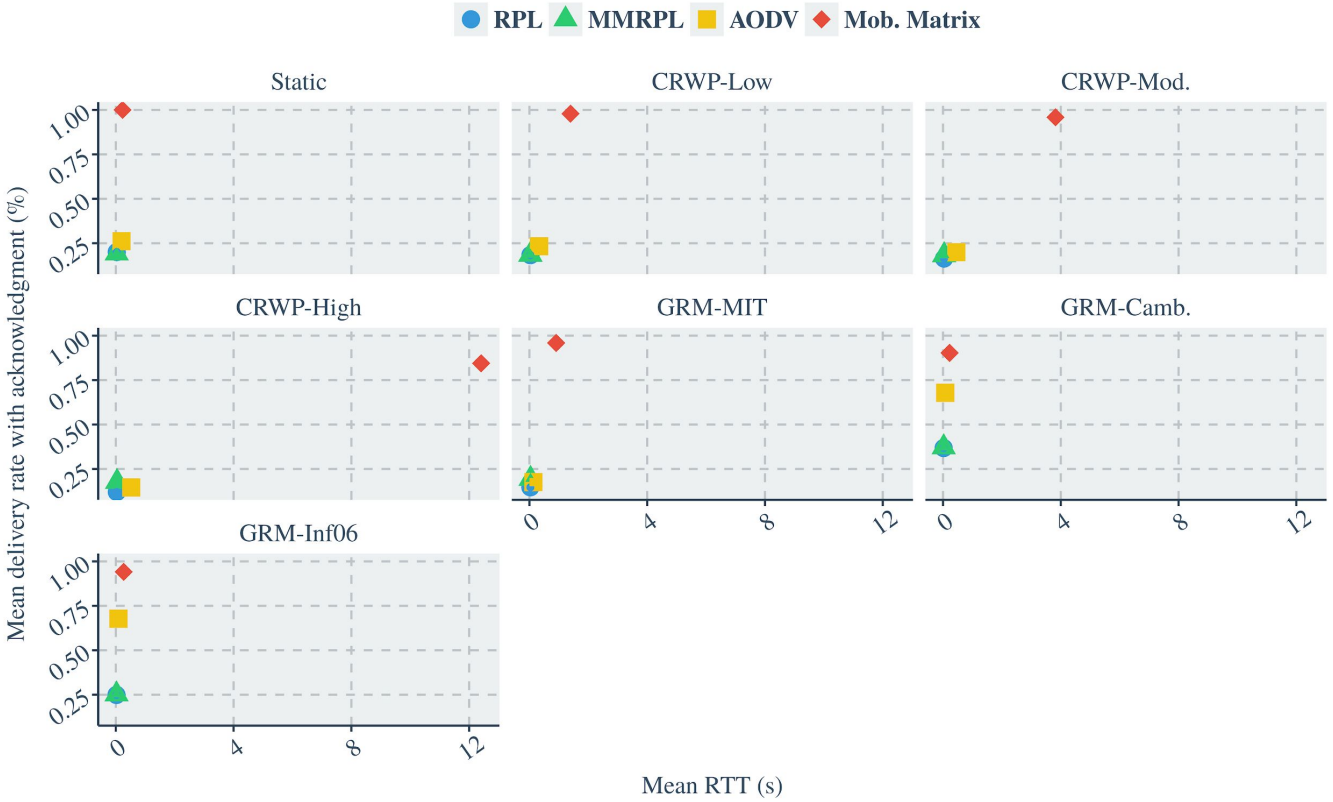
µMatrix Evaluation: Overhead vs Delivery



µMatrix Evaluation: Overhead vs Delivery



µMatrix Evaluation: Trade-off Delivery vs RTT



Reports

1. **Mobile Matrix: A Multihop Address Allocation and Any-To-AnyRouting in Mobile 6LoWPAN**

   ACM MSWiM 2017
2. **Mobile Matrix: Routing under Mobility in IoT, IoMT, and Social IoT**

   Ad Hoc Networks Journal 2018

5.

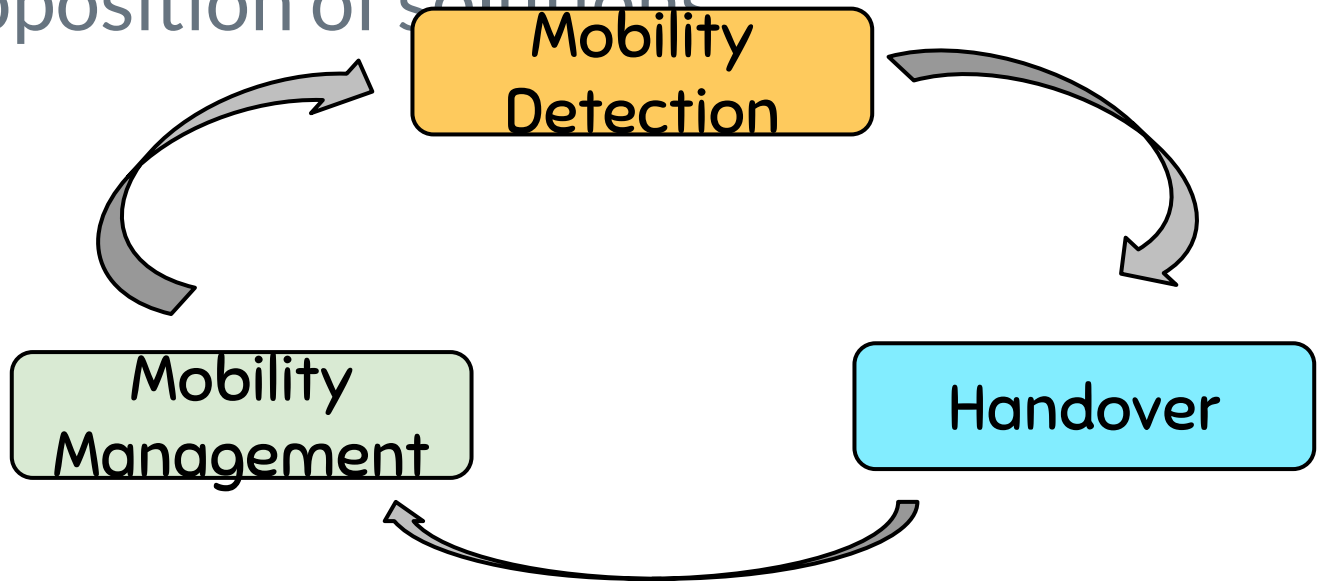
Conclusions and Future Work

- ✓ Final remarks
- ✓ Next directions

Conclusions & Future work

Summary

- We did studies, analyses, and formulated proposition of solutions



List Publications

1. **Internet das Coisas: da teoria à prática**
   SBRC 2016
2. **Mobile Matrix: A Multihop Address Allocation and Any-To-Any Routing in Mobile 6LoWPAN**
   ACM MSWiM 2017
3. **Matrix: Multihop Address allocation and dynamic any-To-any Routing for 6LoWPAN**
   ACM MSWiM 2016
4. **Matrix: Multihop Address allocation and dynamic any-To-any Routing for 6LoWPAN**
   Computer Networks 2018
5. **Mobile Matrix: Routing under Mobility in IoT, IoMT, and Social IoT**
   Ad Hoc Networks Journal 2018
6. **Dribble: a learn-based timer scheme selector for mobility management in IoT.**
   IEEE WCNC 2019

List Publications

1. **Sistemas de Transporte Inteligentes: Conceitos, Aplicações e Desafios**
   SBRC Chapter Book 2016
2. **Towards intra-vehicular sensor data fusion**
   IEEE ITSC 2016
3. **Emerging Wireless Communication and Network Technologies: Principle, Paradigm and Performance**
   Springer Chapter Book 2017
4. **CGR: Centrality-basedgreen routing for Low-power and Lossy Networks**
   Computer Networks 2017
5. **T-MAPS: Modelo de Descrição do Cenário de Trânsito Baseado no Twitter**
   SBRC 2017
6. **Enriching Traffic Information with a Spatiotemporal Model based on Social Media**
   IEEE ISCC 2018

Conclusions & Future work

Ongoing

1. **EXTENTION: Dribble**
   <to be defined>
2. **Internet of Things: from theory to practice**
   IEEE Surveys and Tutorials
3. **Internet of Things meets Mobility: Fundamentals, Trends and Challenges**
   <to be defined>
4. **Road data enrichment framework based on heterogeneous data fusion for ITS**
   Transactions on Intelligent Transportation Systems 2020

Submitted

1. **Internet of Things meets Mobility: Fundamentals, Trends and Challenges**
   IEEE Network: Internet of Things for Smart Cities: Technologies and Applications

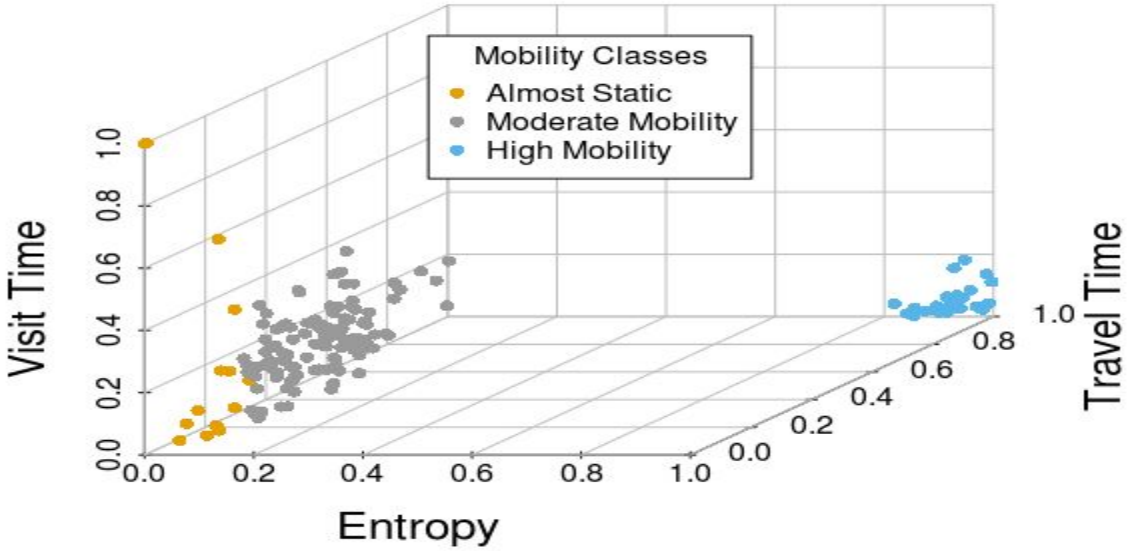
Ongoing

1. **Beacon-Timer: A learn-based timer selector for IoT**
2. **A tutorial of Internet of Things and mobility**
   IEEE Surveys and Tutorials

Summary of next steps

µMatrix Extensions

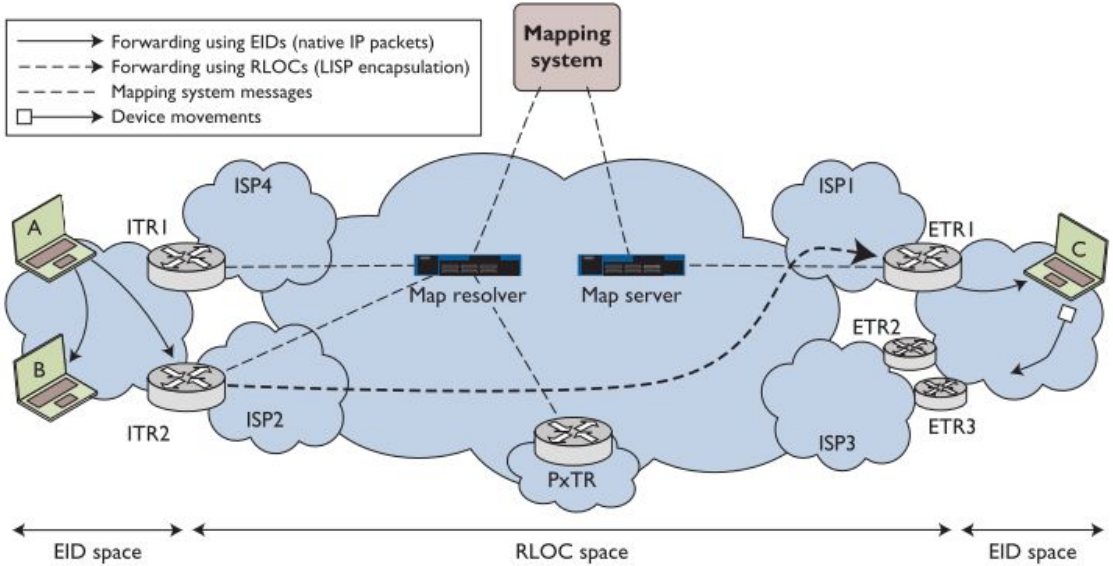
1. Mobility Detection



Summary of next steps

μMatrix Extensions

1. Mobility Detection
2. Inter-domain routing with *μ*Matrix

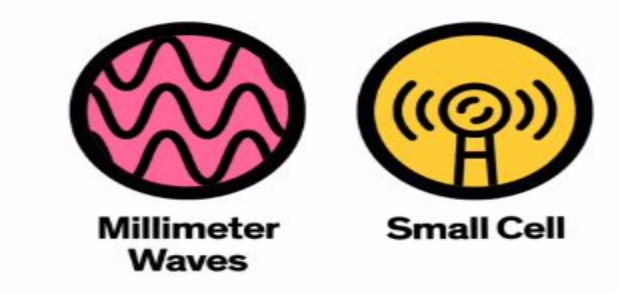

Forwarding using EIDs (native IP packets)
Forwarding using RLOCs (LISP encapsulation)
Mapping system messages
Device movements
Mapping system
ISP4
ISP1
A
ITR1
ETR1
C
Map resolver
Map server
ETR2
B
ITR2
ISP2
ISP3
ETR3
PxTR
EID space
RLOC space
EID space

Summary of next steps

IoT on 5G context

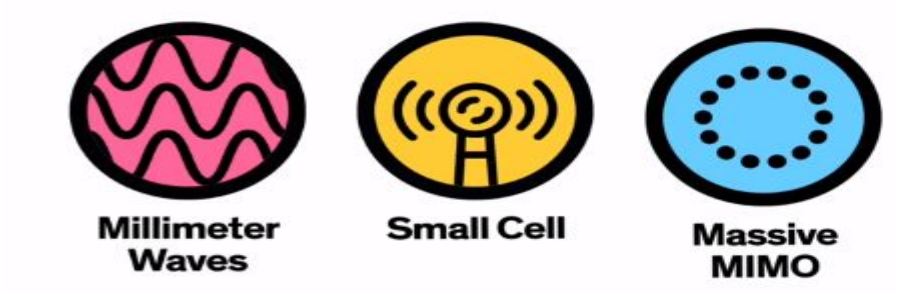
Summary of next steps

IoT on 5G context



Summary of next steps

IoT on 5G context



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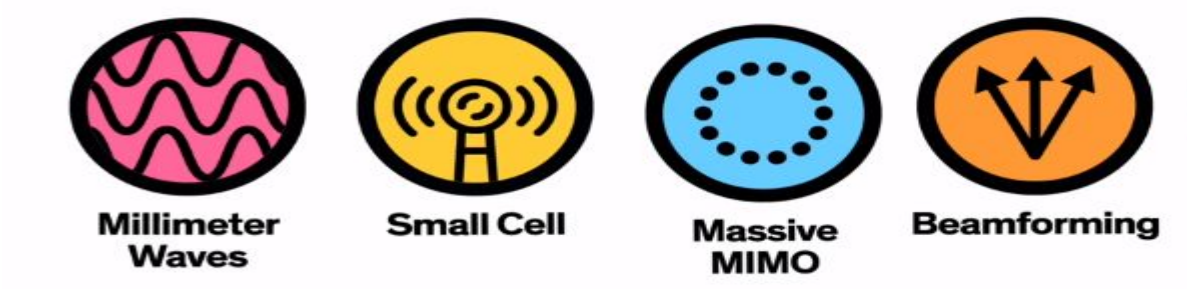
IoT on 5G context



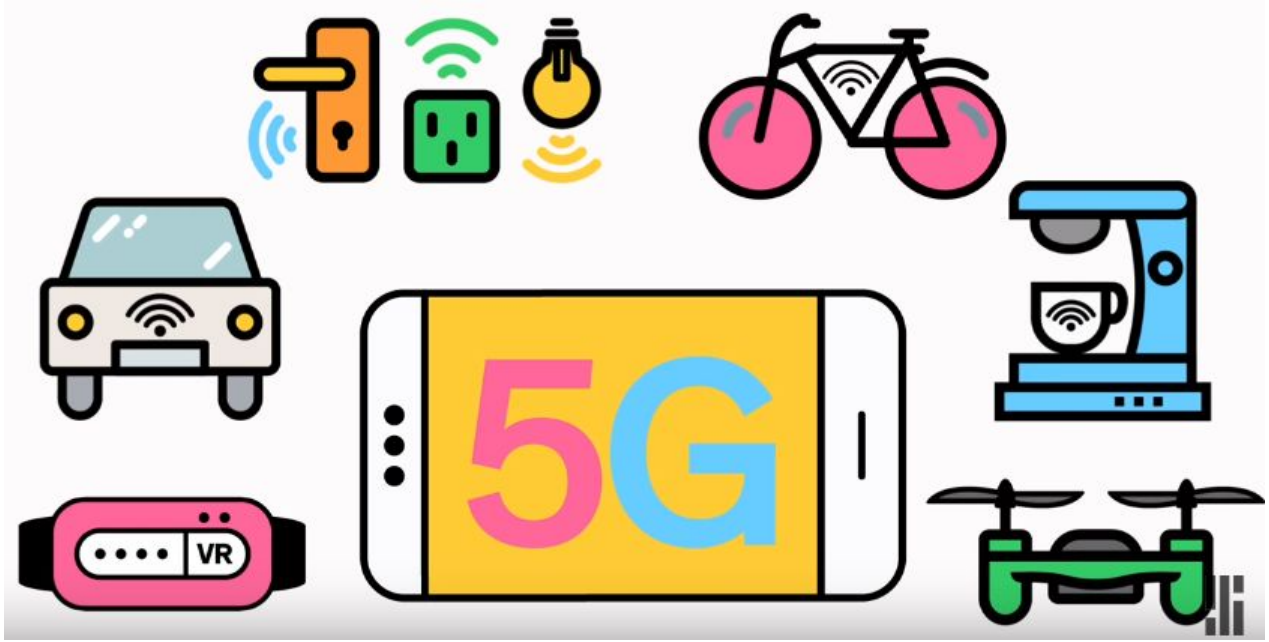
Summary of next steps

IoT on 5G context

Fonte:IEEE 5G

Summary of next steps

IoT on 5G context

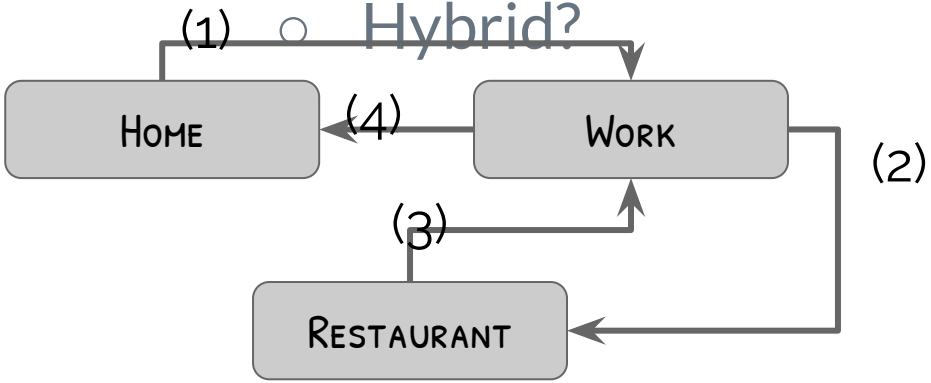


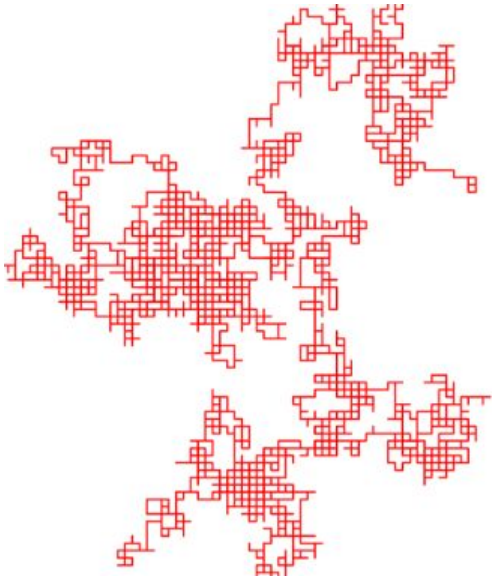
Fonte:IEEE 5G

Summary of next steps

Social IoT

- Mobility pattern
  - Human like?
  - Non-human like?
  - Hybrid?





Acknowledgement

My warm thanks to everyone who supported me and contributed in different ways to the development of this work.

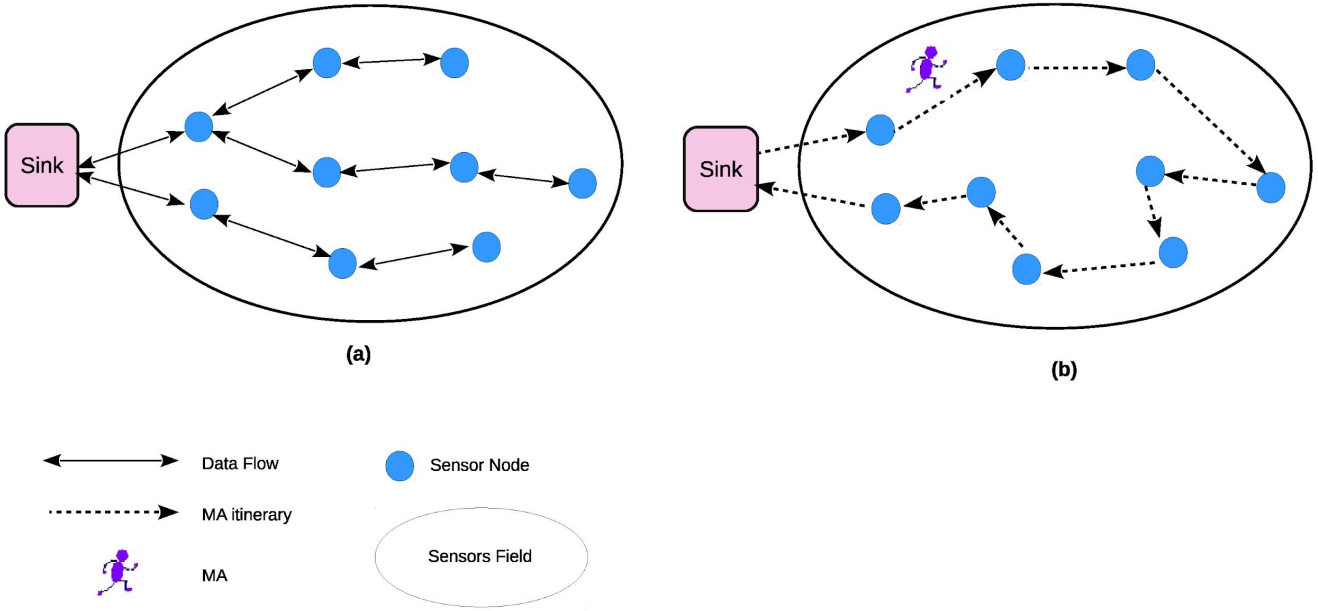
Thanks to my advisors for their guidance and expertise were fundamental in the formulating of the research topic and methodology.

It is important to thank my family and dear friends for affection, encouragement, and friendship.

Universidade Estadual de Santa Cruz
FAPEMIG
CAPES
CNPq
UFMG UNIVERSIDADE FEDERAL DE MINAS GERAIS

Summary of next steps

Mobile Agents and IoT



Thanks!

Any questions?

You can find me at:

bruno.ps@dcc.ufmg.br

Summary of next steps

Planned Schedule

Activities	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
μMatrix Extensions: mobility detection	■	■	■									
μMatrix Extensions: inter-domain routing			■	■	■	■						
Social IoT mobility model and applications						■	■	■				
Mobile Agents									■	■		
5G and IoT						■	■	■	■	■	■	■
Writing pub. and final dissertation		■	■	■		■	■		■	■	■	■
Final presentation											■	■

Summary of next steps

Planned Schedule

Activities	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
μMatrix Extensions: mobility detection	X	X	■									
μMatrix Extensions: inter-domain routing			■	■	■	■						
Social IoT mobility model and applications						■	■	■				
Mobile Agents									■	■		
5G and IoT						■	■	■	■	■	■	■
Writing pub. and final dissertation		X	■	■		■	■		■	■	■	■
Final presentation											■	■

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1.

TRANSITION HEADLINE

Move to T-MAPS and Matrix ppt...

Quotations are commonly printed as a means of inspiration and to invoke philosophical thoughts from the reader.

This is a slide title

- Here you have a list of items
- And some text
- But remember not to overload your slides with content

Your audience will listen to you or read the content, but won't do both.

Big concept

Bring the attention of your audience over a key concept using icons or illustrations

You can also split your content

White

Is the color of milk and fresh snow, the color produced by the combination of all the colors of the visible spectrum.

Black

Is the color of coal, ebony, and of outer space. It is the darkest color, the result of the absence of or complete absorption of light.

In two or three columns

Yellow

Is the color of gold, butter and ripe lemons. In the spectrum of visible light, yellow is found between green and orange.

Blue

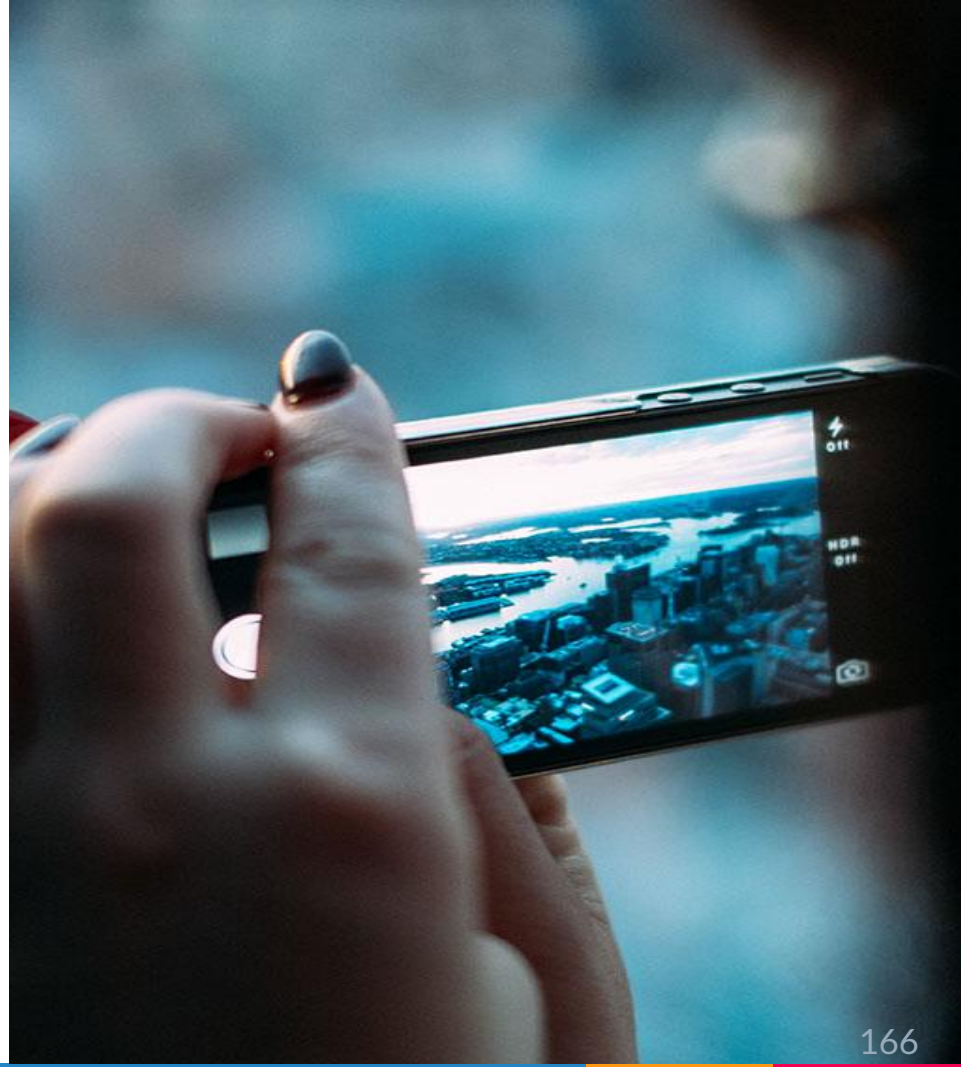
Is the colour of the clear sky and the deep sea. It is located between violet and green on the optical spectrum.

Red

Is the color of blood, and because of this it has historically been associated with sacrifice, danger and courage.

A picture is worth a thousand words

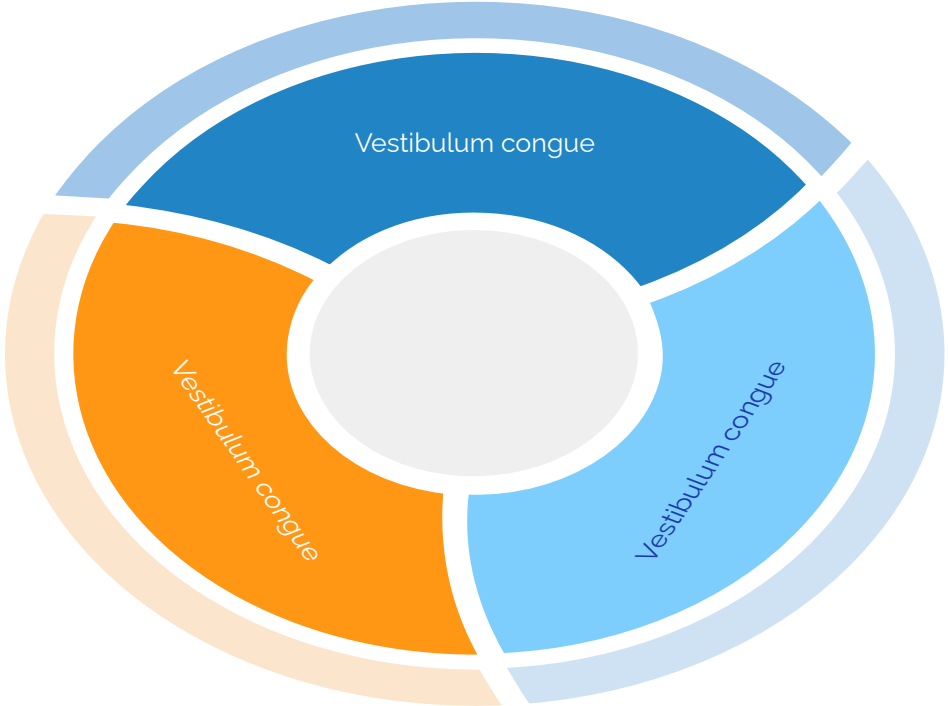
A complex idea can be conveyed with just a single still image, namely making it possible to absorb large amounts of data quickly.



Want big impact?

Use big image.

Use diagrams to explain your ideas



And tables to compare data

	A	B	C
Yellow	10	20	7
Blue	30	15	10
Orange	5	24	16

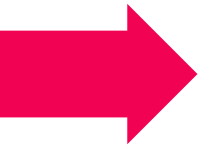
Maps

89,526,124

Whoa! That's a big number, aren't you proud?

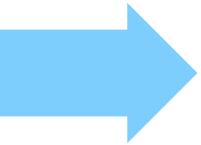
89,526,124$

That’s a lot of money



185,244 users

And a lot of users



100%

Total success!

Our process is easy

Lorem ipsum dolor sit amet, consectetur adipiscing elit.

Lorem ipsum dolor sit amet, consectetur adipiscing elit.

Lorem ipsum dolor sit amet, consectetur adipiscing elit.

Let's review some concepts

Yellow

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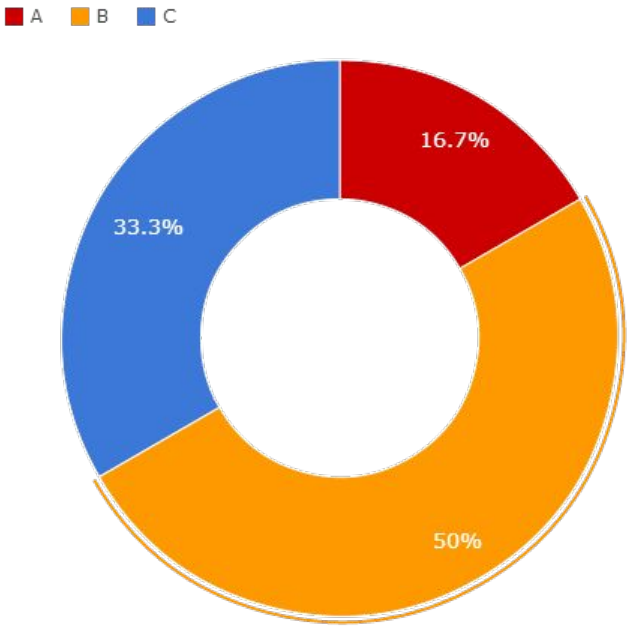

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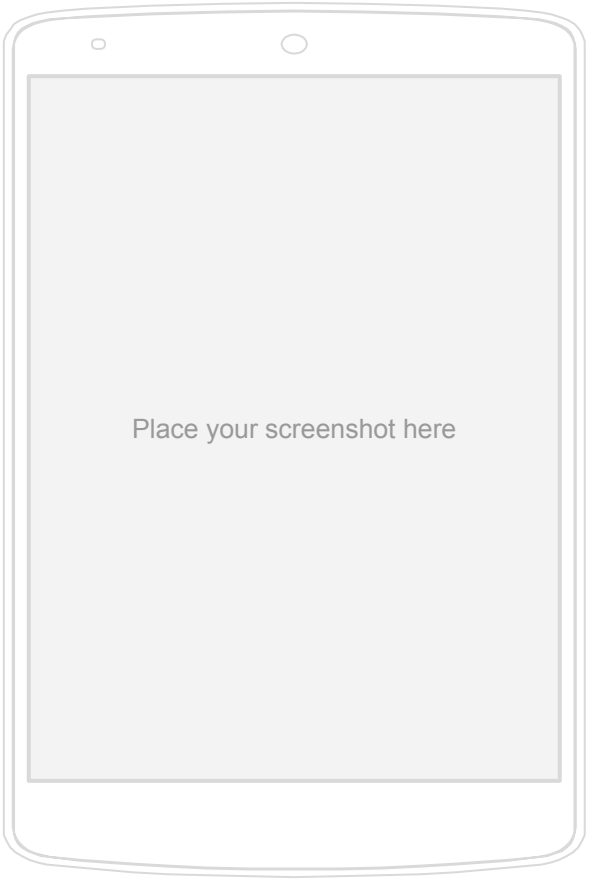

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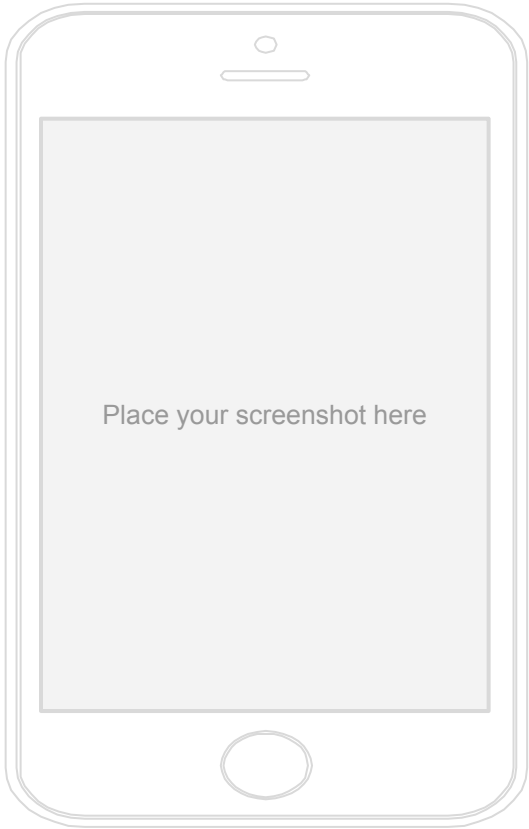

Tablet project

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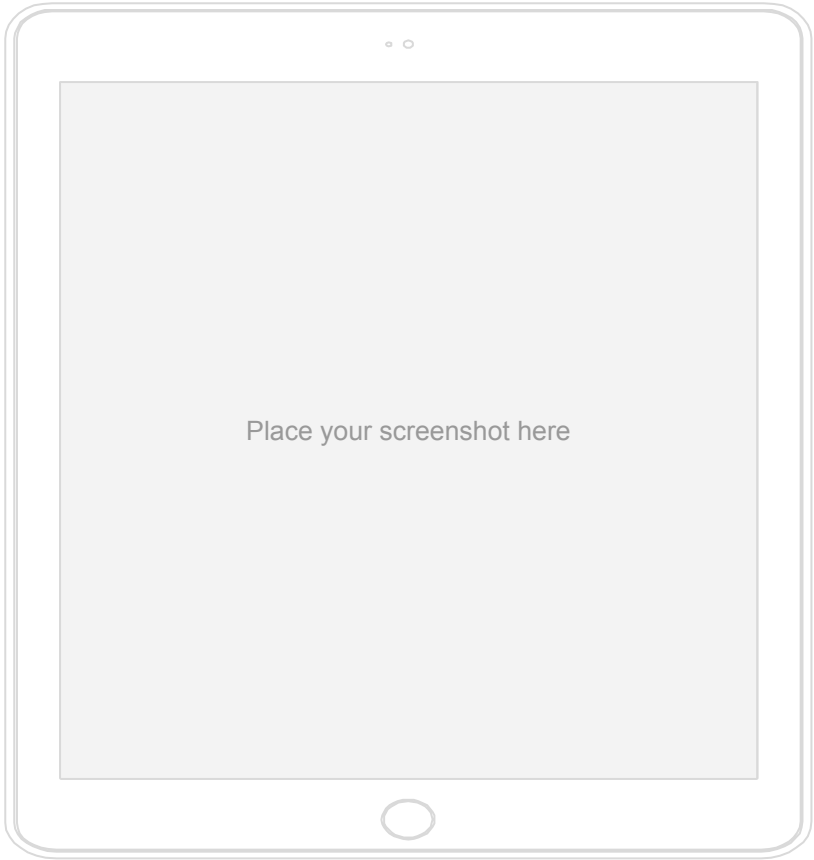

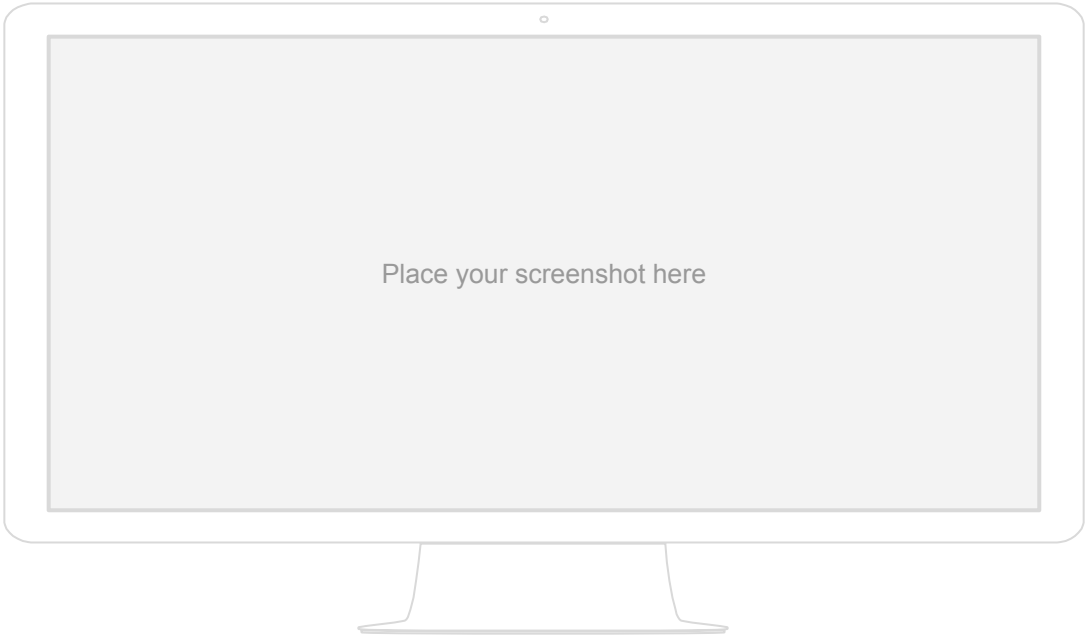

Desktop project

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- Magenta **#f20253**

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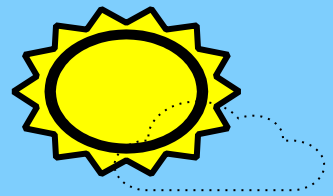

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