Results of the Demonstration of Shared Spectrum Access of Different User Groups and Changing Priorities

Fairspectrum

Authors

Topi Tuukkanen, (Finnish Defence Research Agency)
Heikki Kokkinen (Fairspectrum, Finland) ,
Seppo Yrjölä (Nokia, Finland),
Jaakko Ojaniemi (Fairspectrum, Finland),
Arto Kivinen (Fairspectrum, Finland),
Jarkko Paavola (Turku University of Applied Sciencies)

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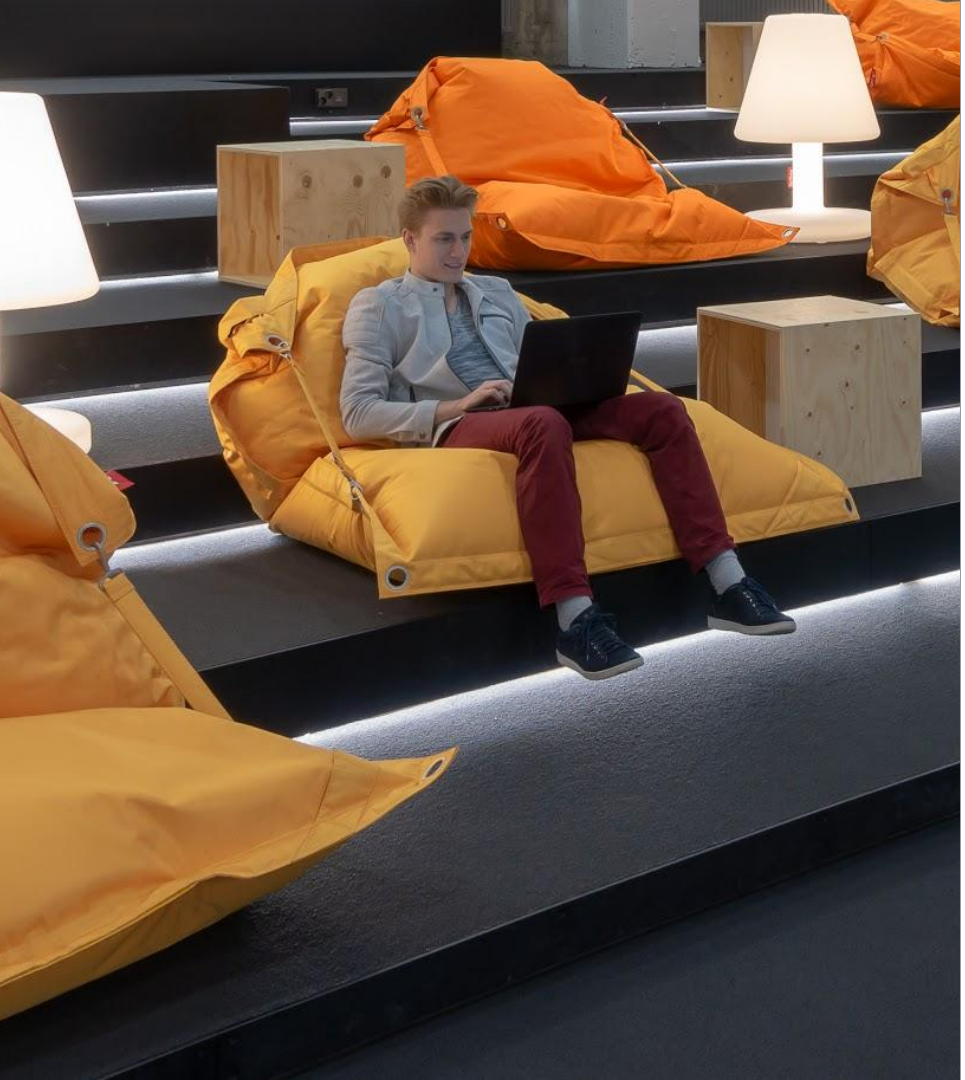

Introduction

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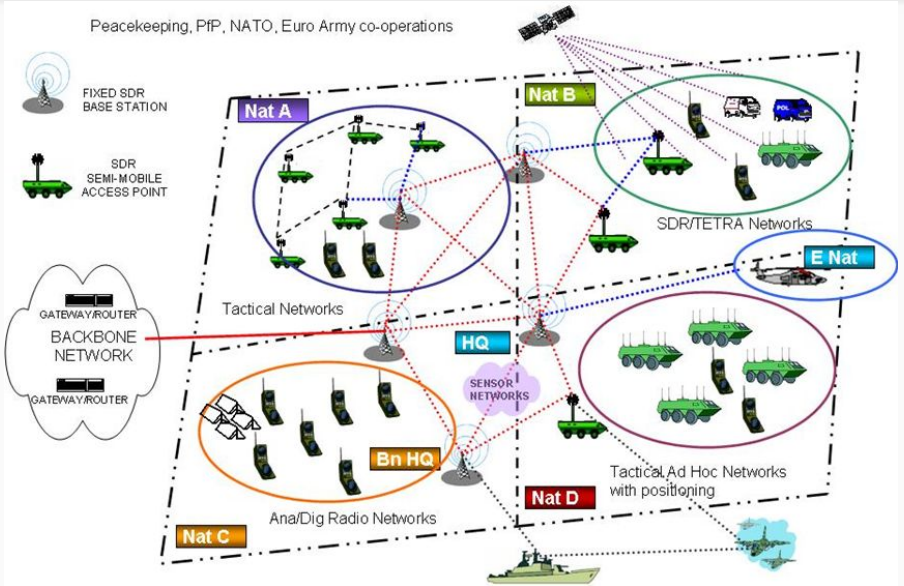
Army Digital Battlefield

- Armed forces' requirements for spectrum access vary over time and location
- Rigid and fixed spectrum management schemes do not provide military any incentive to relinquish exclusive access to spectrum



Model of changing priorities

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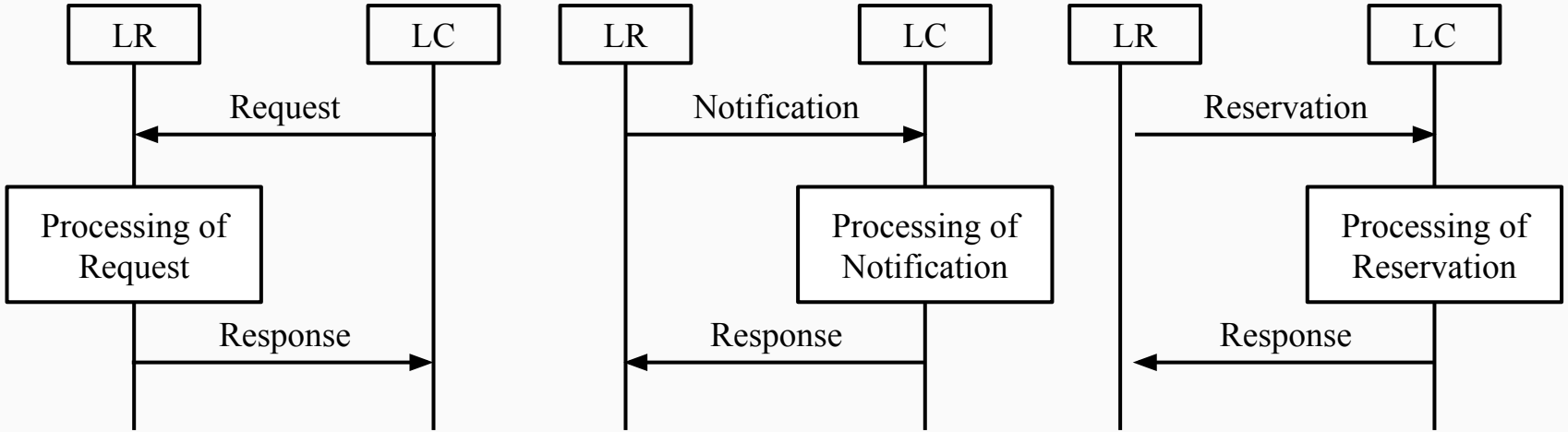
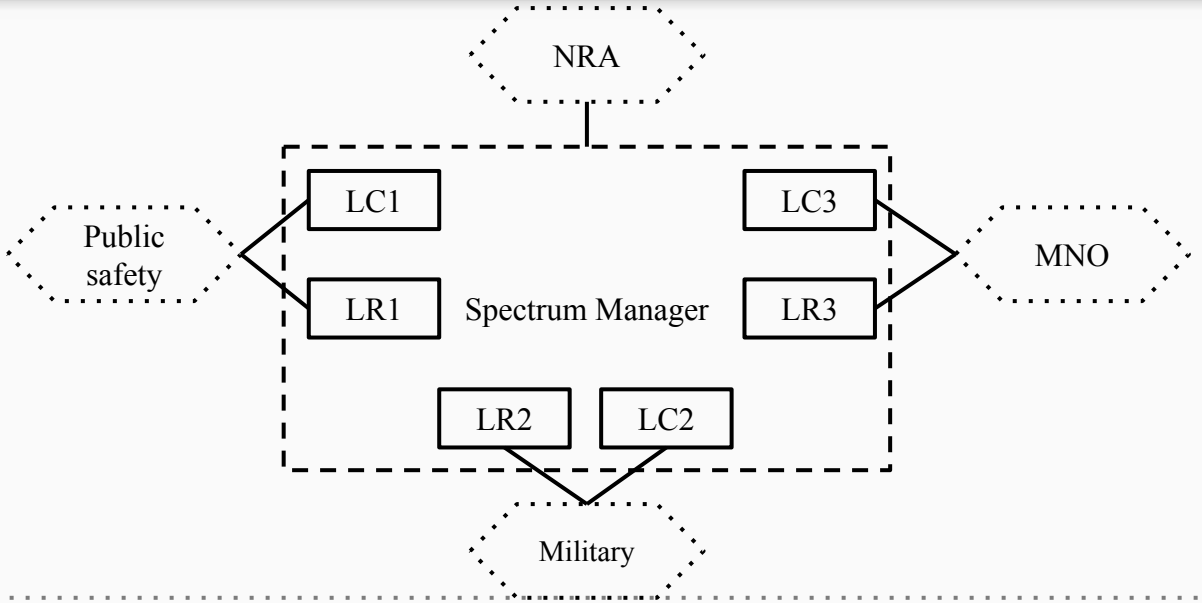
Request, Notification and Reservation Procedures

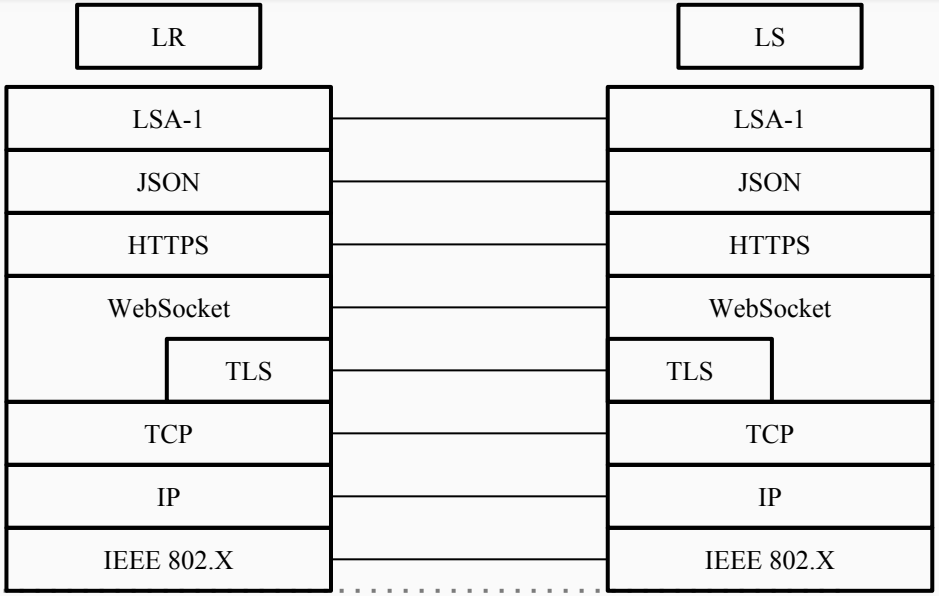


LSA with multiple Repositories and Controllers

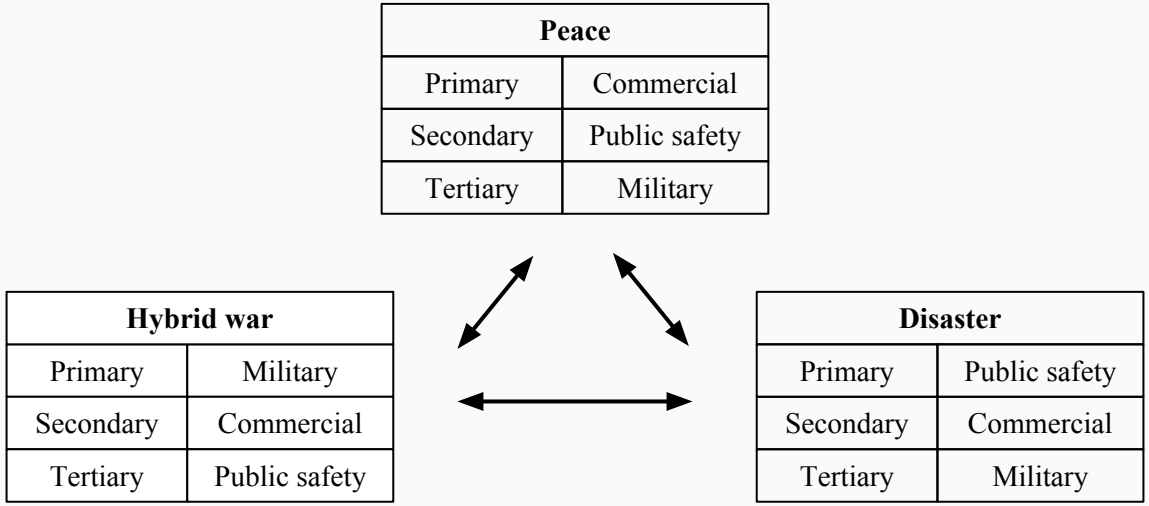


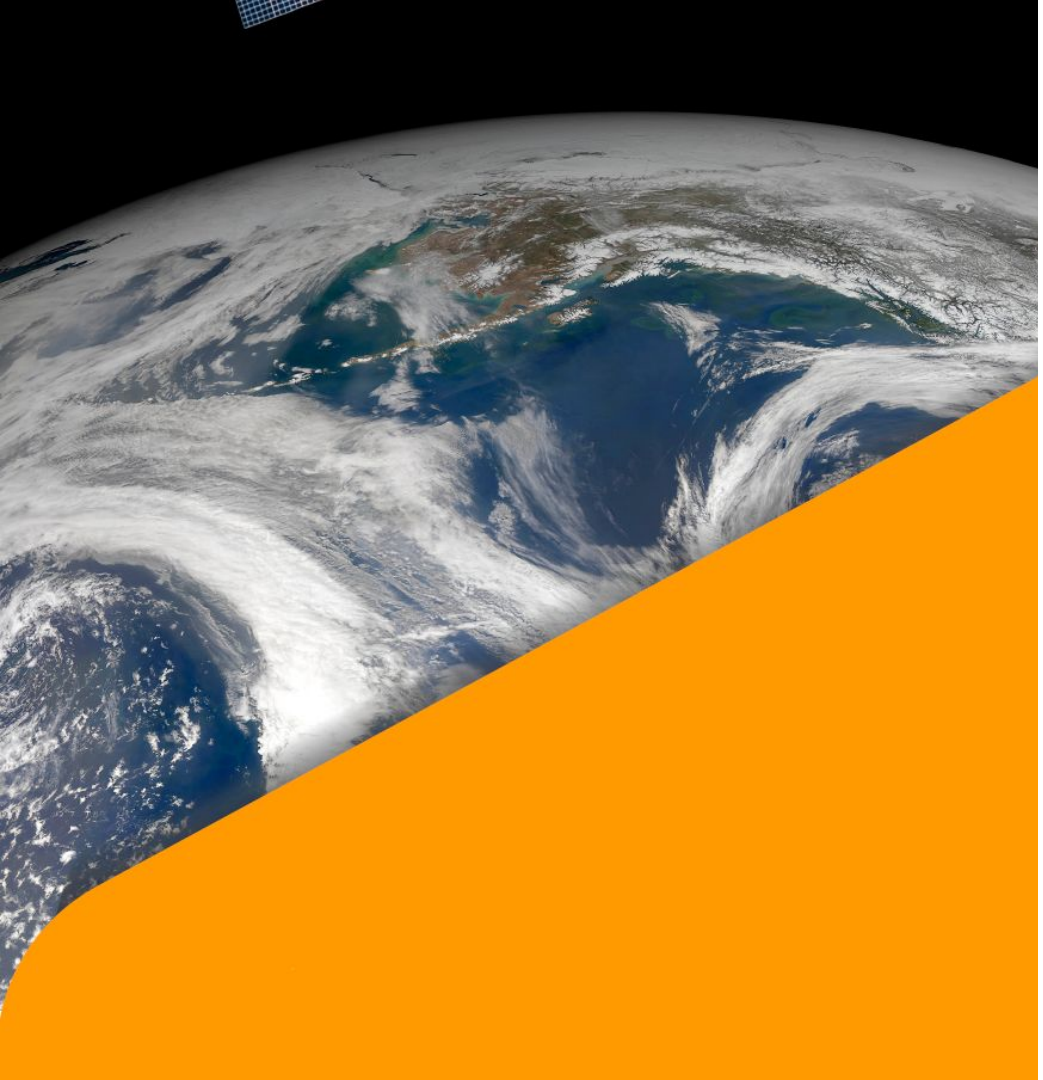
Protocol stack for changing priorities

- In Notification protocols, an intermediate connectivity layer is needed, just like in email app in the mobile phone
- Websocket used in this study



Priority changes between three priority order states





Experimental system setup

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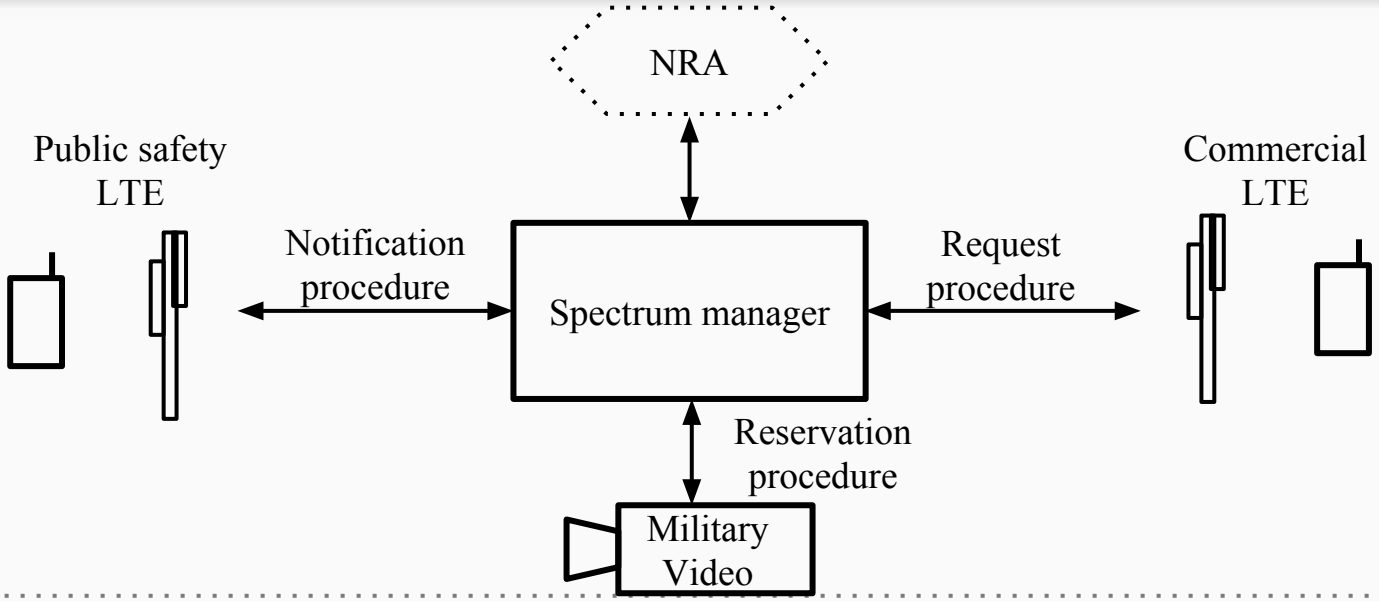
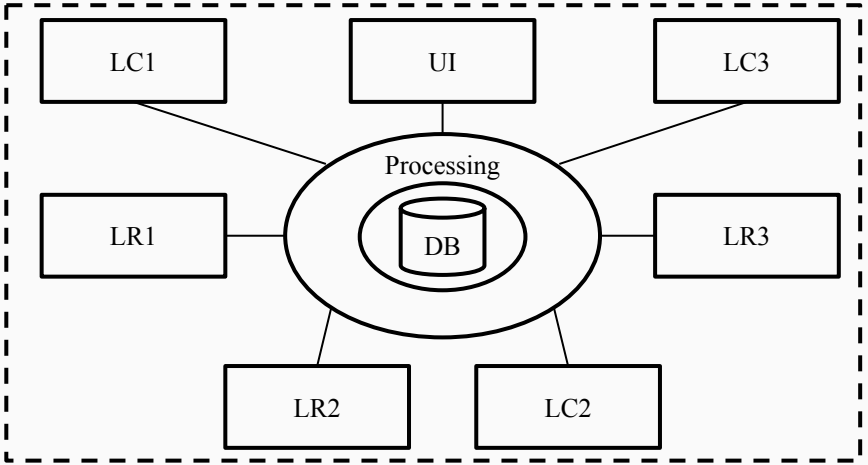
Demonstration system



Spectrum Manager architecture

- Perimeter security model
- Amazon EC2 VPC
- C++, Python, PHP



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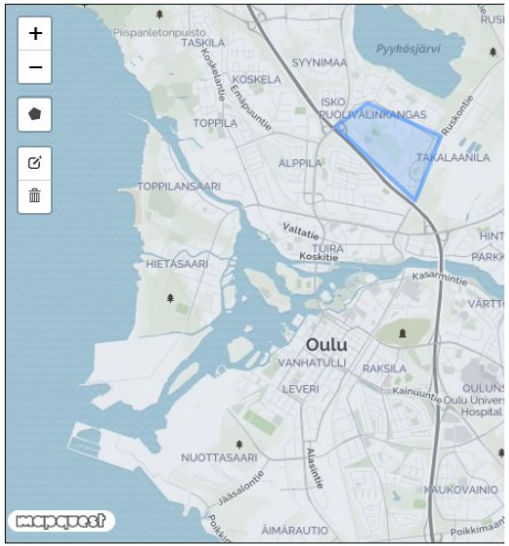
NRA User Interface



Finland Varsinais-Suomi Free

Begin and end time

20.04.2018 To: 21.04.2018

State of priority

Peace

Location name

Save priority definition

Spectrum priority

	Peace	Disaster	Combat
Commercial	1	2	3
PPDR	2	1	2
Military	3	3	1

Save spectrum priority

Priority definitions

Start	End	Case	Location name	Delete
2018-04-04 09:17:21+00	2018-04-05 09:17:21+00	Peace	Finland	Delete
2018-04-04 09:20:45+00	2018-04-05 09:20:45+00	Combat	Turku center	Delete
2018-04-04 09:22:24+00	2018-04-05 09:22:24+00	Peace	Ruoholahti	Delete
2018-04-04 09:26:44+00	2018-04-05 09:26:44+00	Combat	Ahvenlampi	Delete

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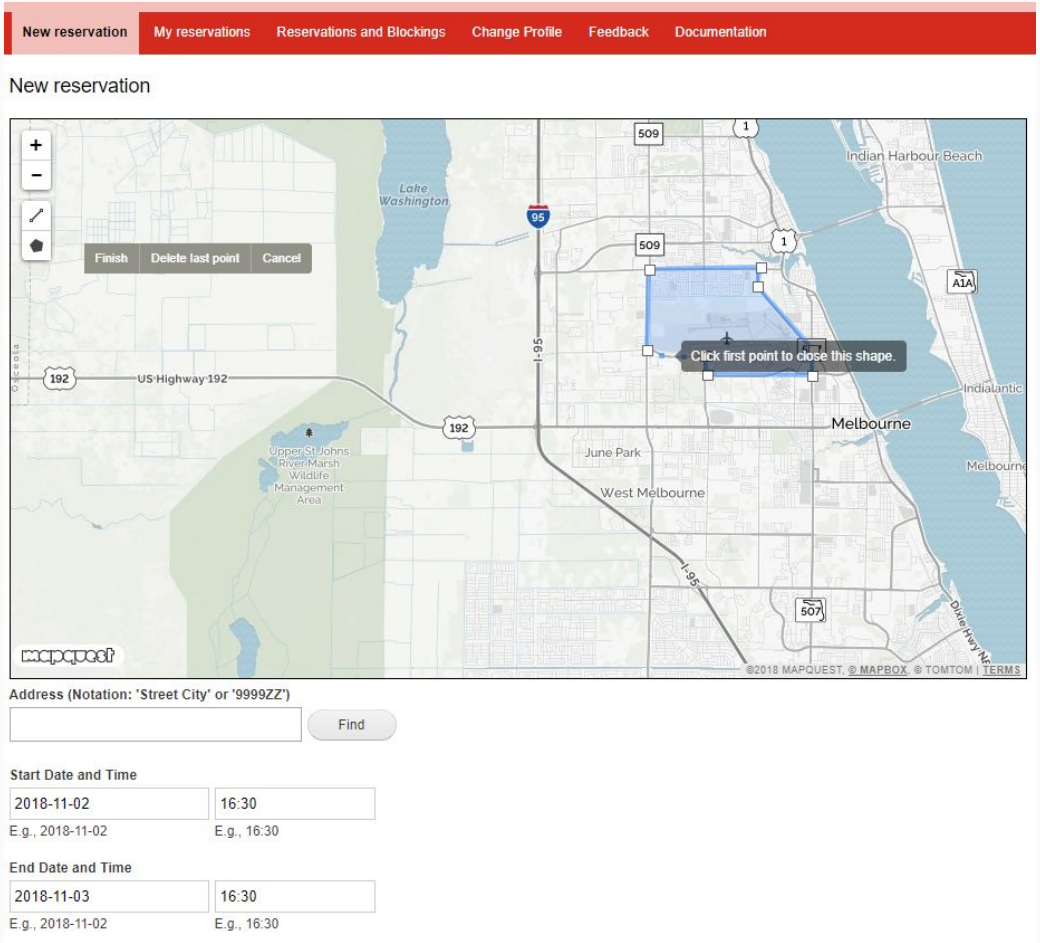
User interface for reservations



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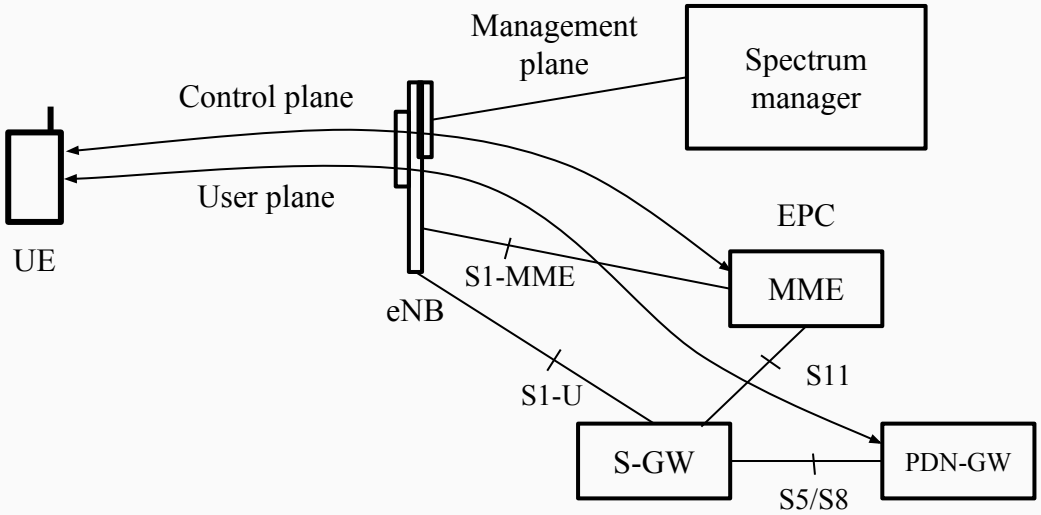
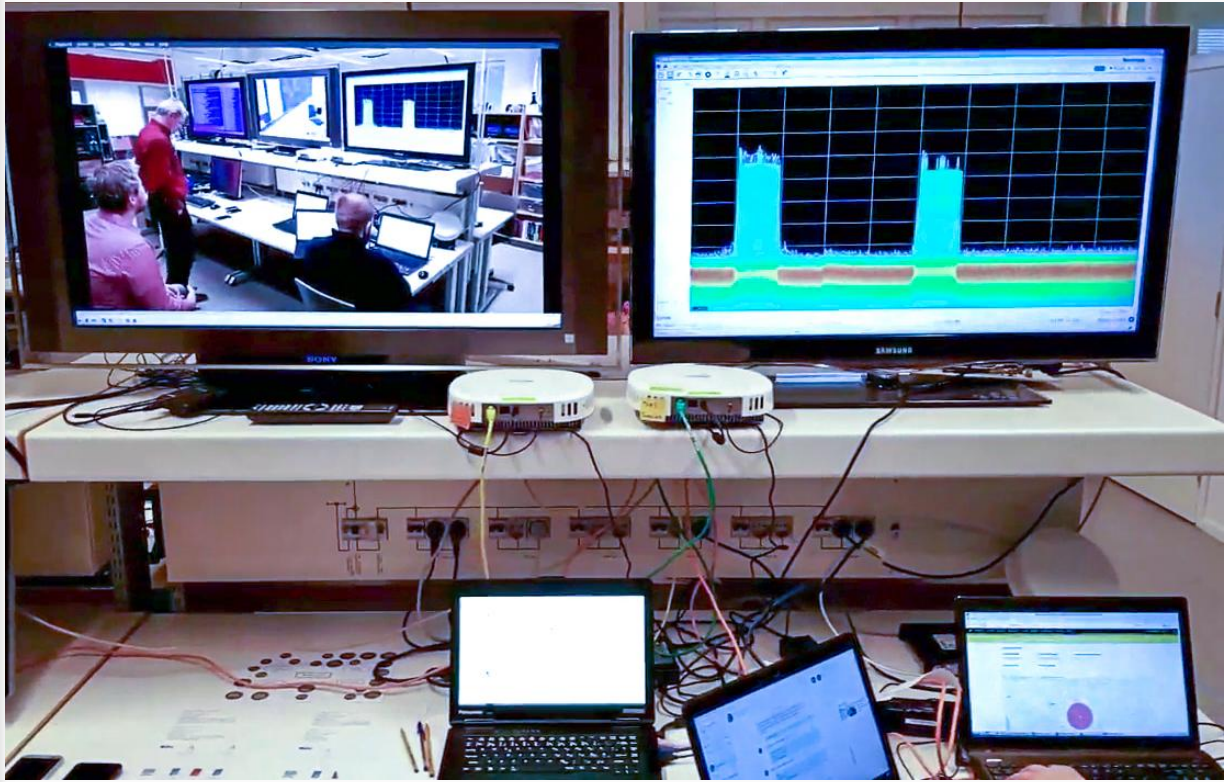
Simplified LTE network

- Off-the-shelf 2.3 GHz devices
- UEs
- eNodeBs
- EPC
- Management plane of eNB



eNodeBs as part of demonstration network



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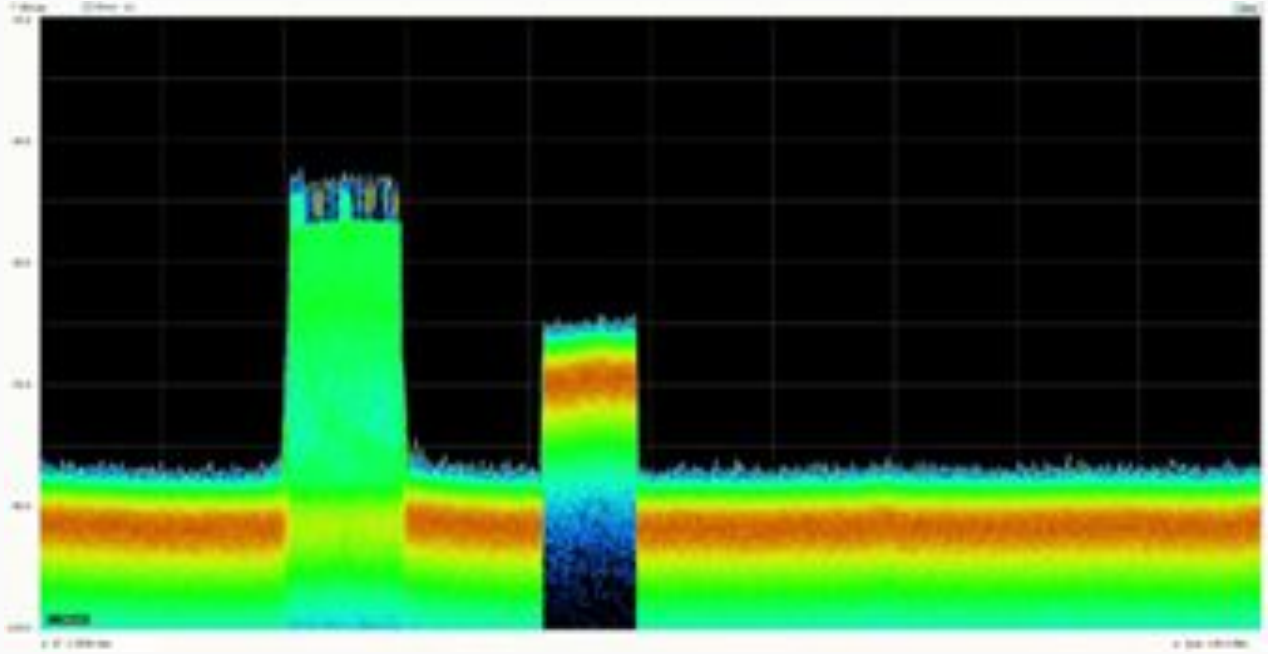
Spectrum analyzer image of military transmitter (right) and LTE (left)



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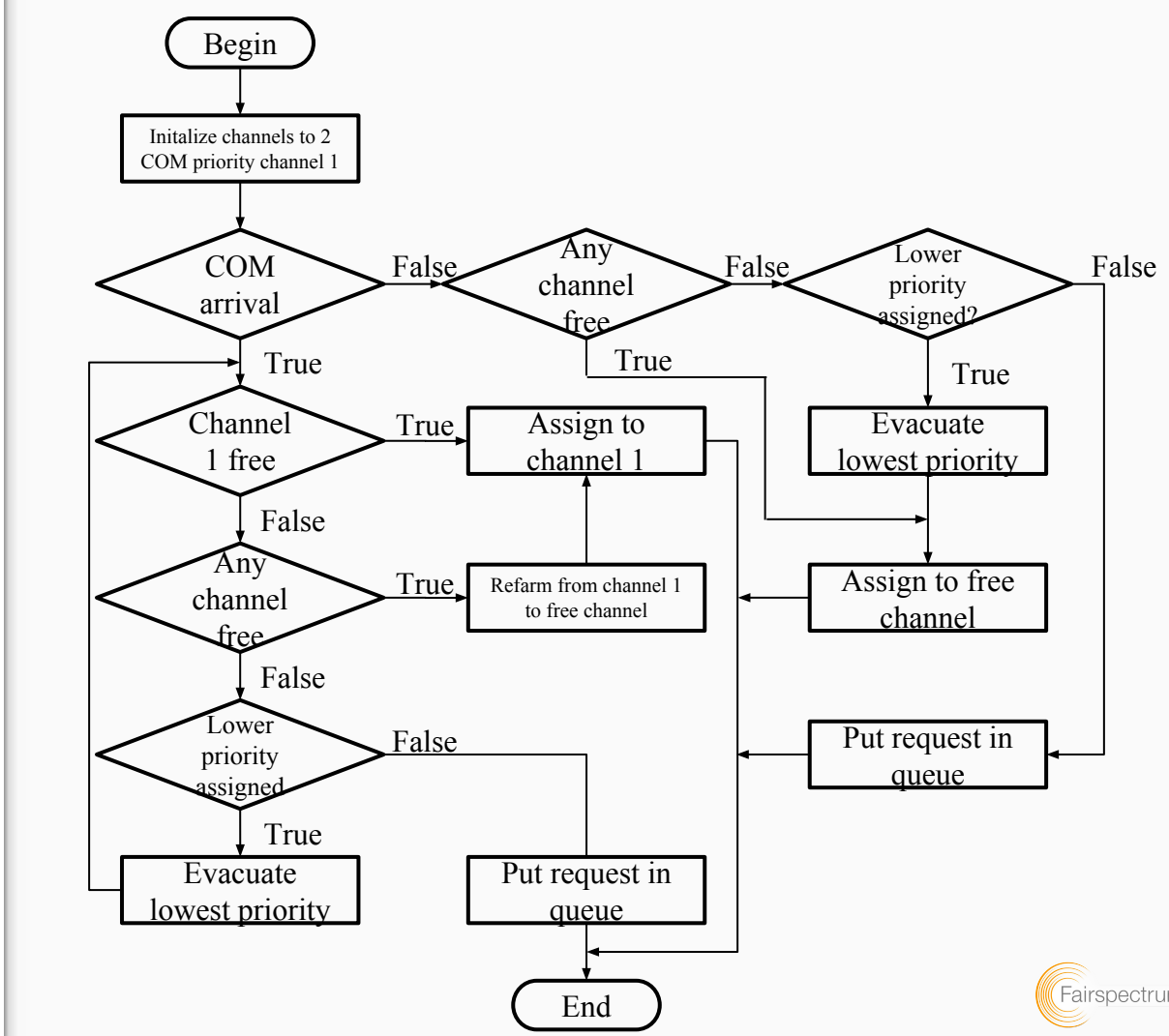
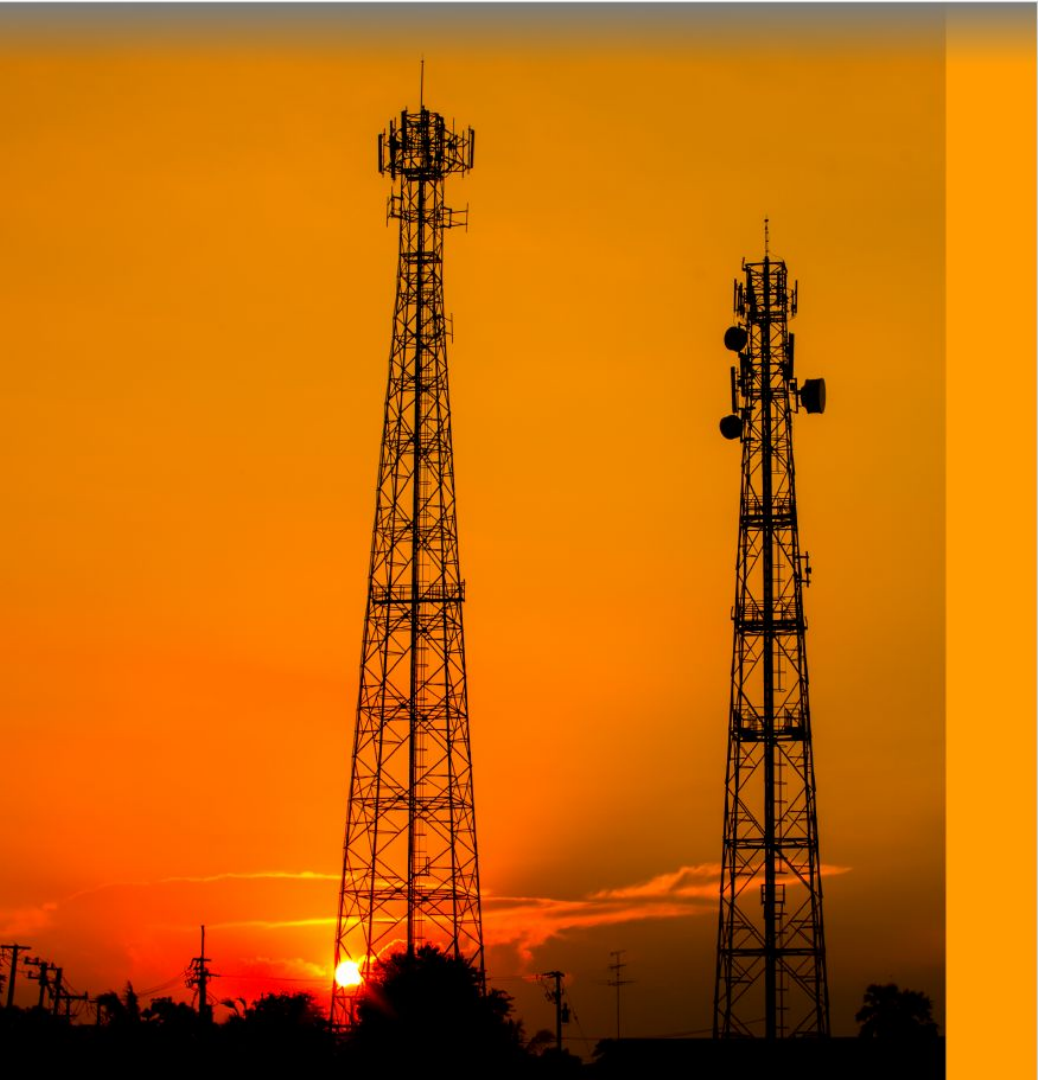
Spectrum allocation algorithm





Experimental validation of procedures with changing priorities

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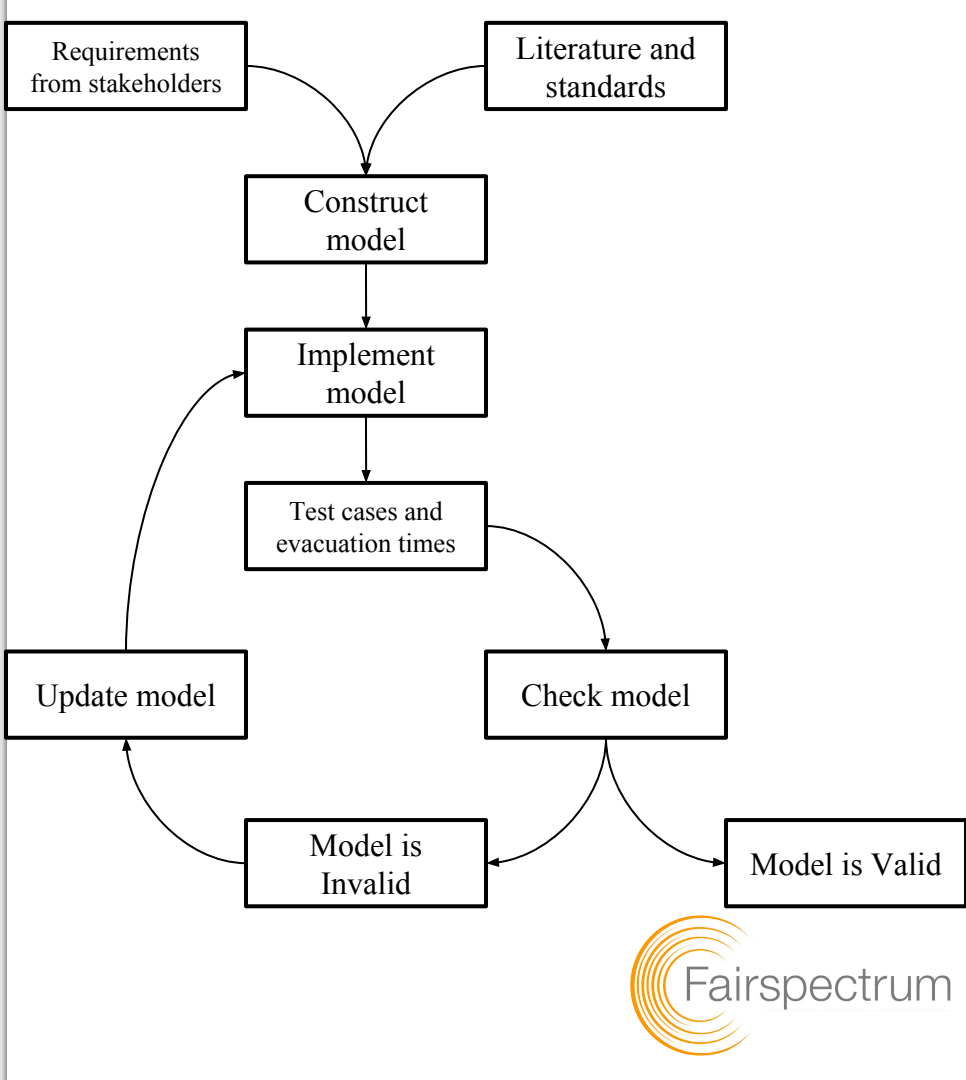
Validation workflow



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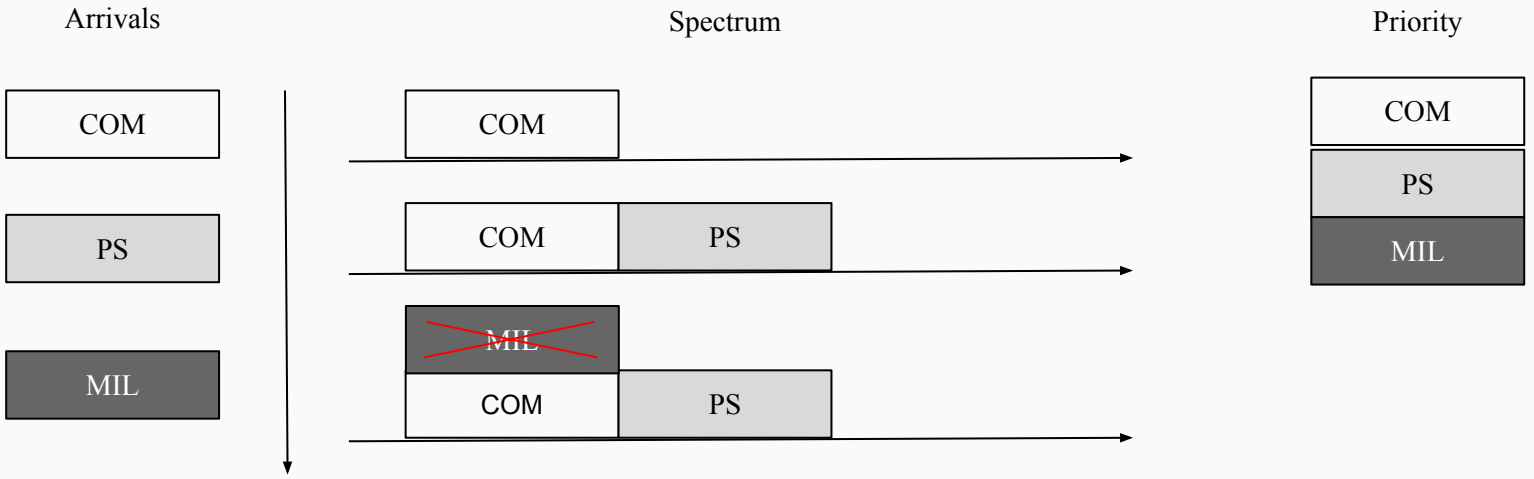
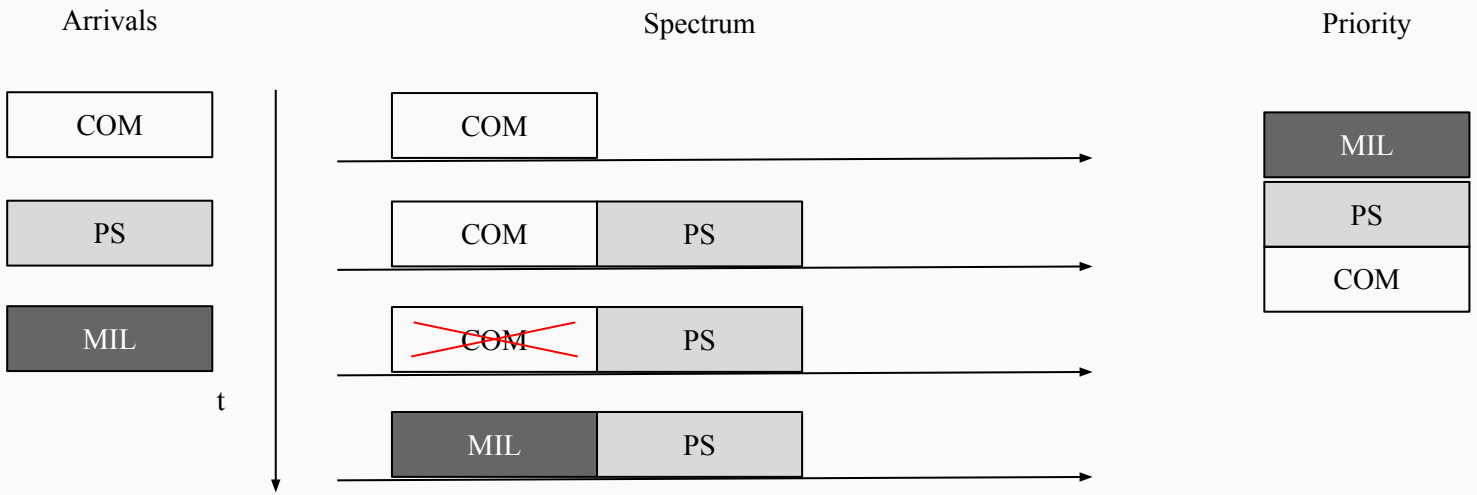
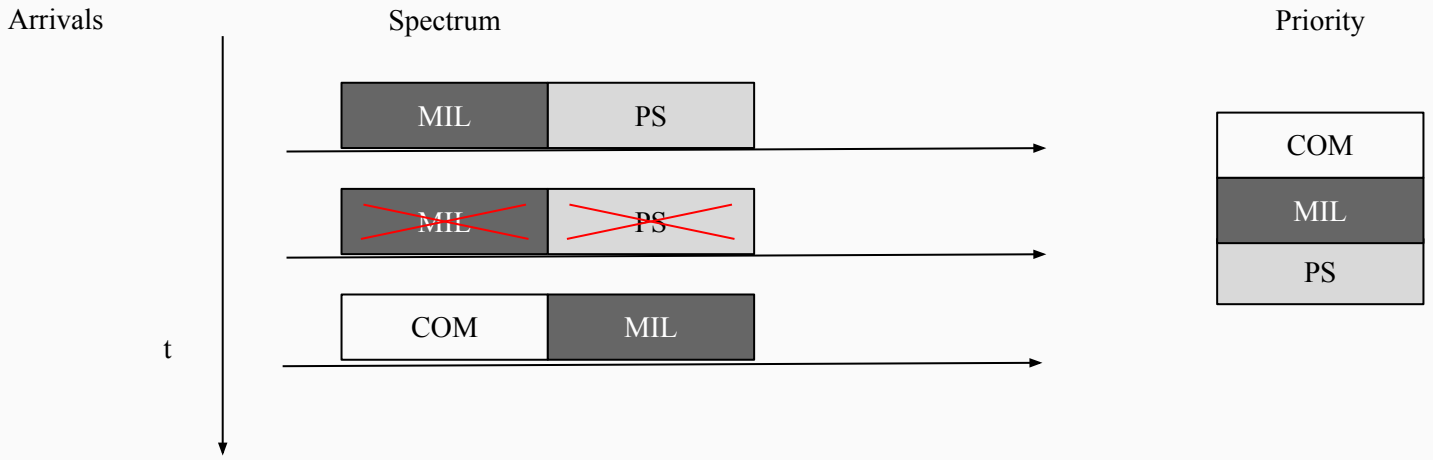
Denial of entry when no capacity



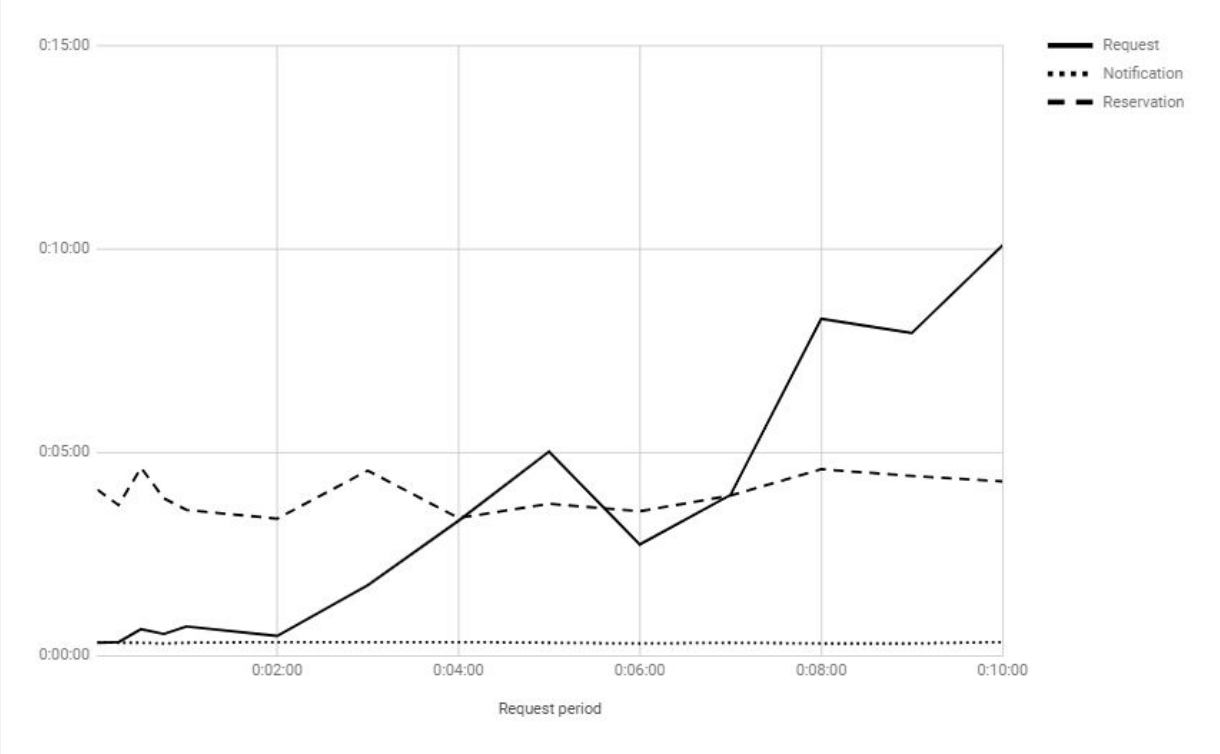
Initial allocation with alternative priority order



Priority change under high spectrum demand



Evacuation times with Request, Notification, and Reservation procedures.



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Conclusions

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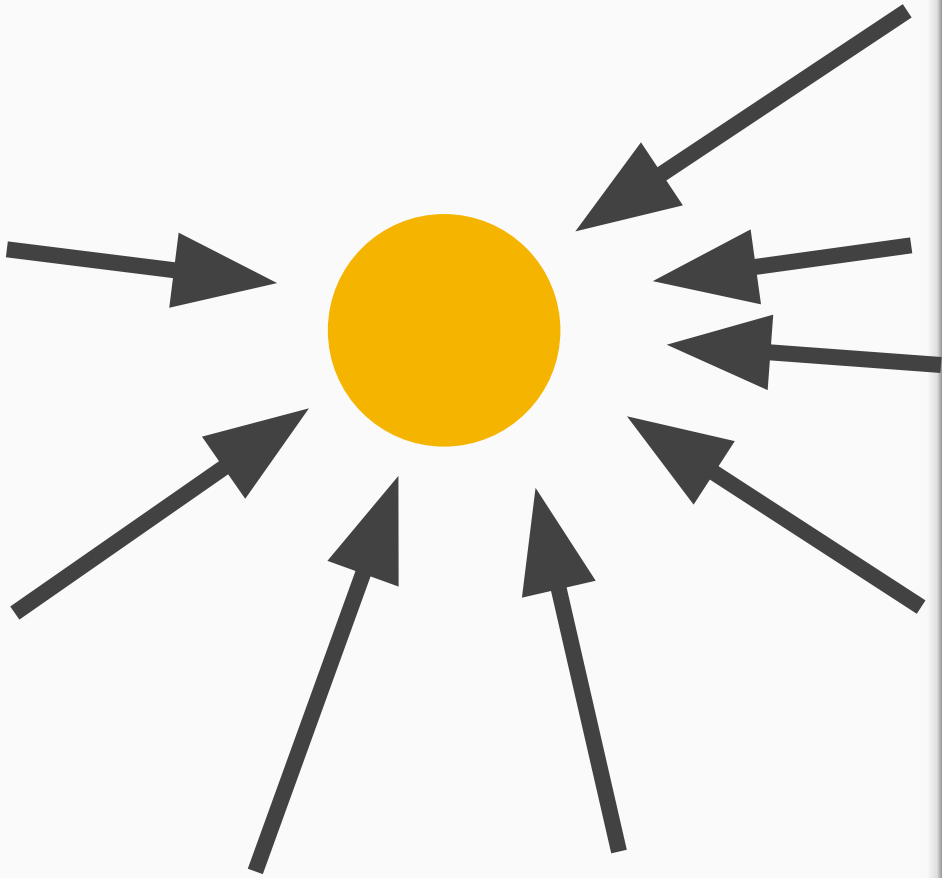
Summary



Dynamic spectrum access system for changing priorities

- Controlled by NRA UI
- Experimental validation
- Evacuation time for Request, Notification, and Reservation procedures

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Future work

- Evacuation time measurements using with incumbent sensors
- Licensee activity sensors at the location of the higher priority user
- Extension of the changing priority spectrum sharing model with a better propagation model
- Larger number of devices, and with different controls, including power level, center frequency change, and bandwidth change

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