# Integration between Terrestrial and Satellite Networks: the PPDR-TC vision

**C. A. Grazia**, M. Klapez, N. Patriciello, M. Casoni, A. Amditis, E. Sdongos, H. Gierszal, D. Kanakidis, C. Katsigiannis, K. Romanowski, P.Simplicio, A.Oliveira, S. Sonander, J. Jackson

Department of Engineering *Enzo Ferrari*
University of Modena and Reggio Emilia



Larnaca, Cyprus, October 8, 2014
**Emergency Networks for PPDR Workshop**
Part of IEEE WiMob 2014

# The PPDR-TC project: Public Protection and Disaster Relief - Transformation Center

## PPDR-TC goals

- Effective Public Protection & Disaster Relief (PPDR) communications
- Preparation of the next generation of PPDR systems

The Consortium:

# Context

## PPDR needs

To provide data-intensive communication in disaster scenarios

## State of reality in the EU

- **Interoperability:** different nations/agencies $\rightarrow$ different networks
- **Performance:** old technologies (e.g TETRA, analog PMR)
  - Good for voice
  - Bad for data
- **Reliability:** commercial infrastructure problem:
  - congestion
  - disruption from disasters

# Long-term goals

## Availability

We want coverage to be almost ubiquitous

## Resilience

We want the network to keep providing service even in hard and unexpected situations

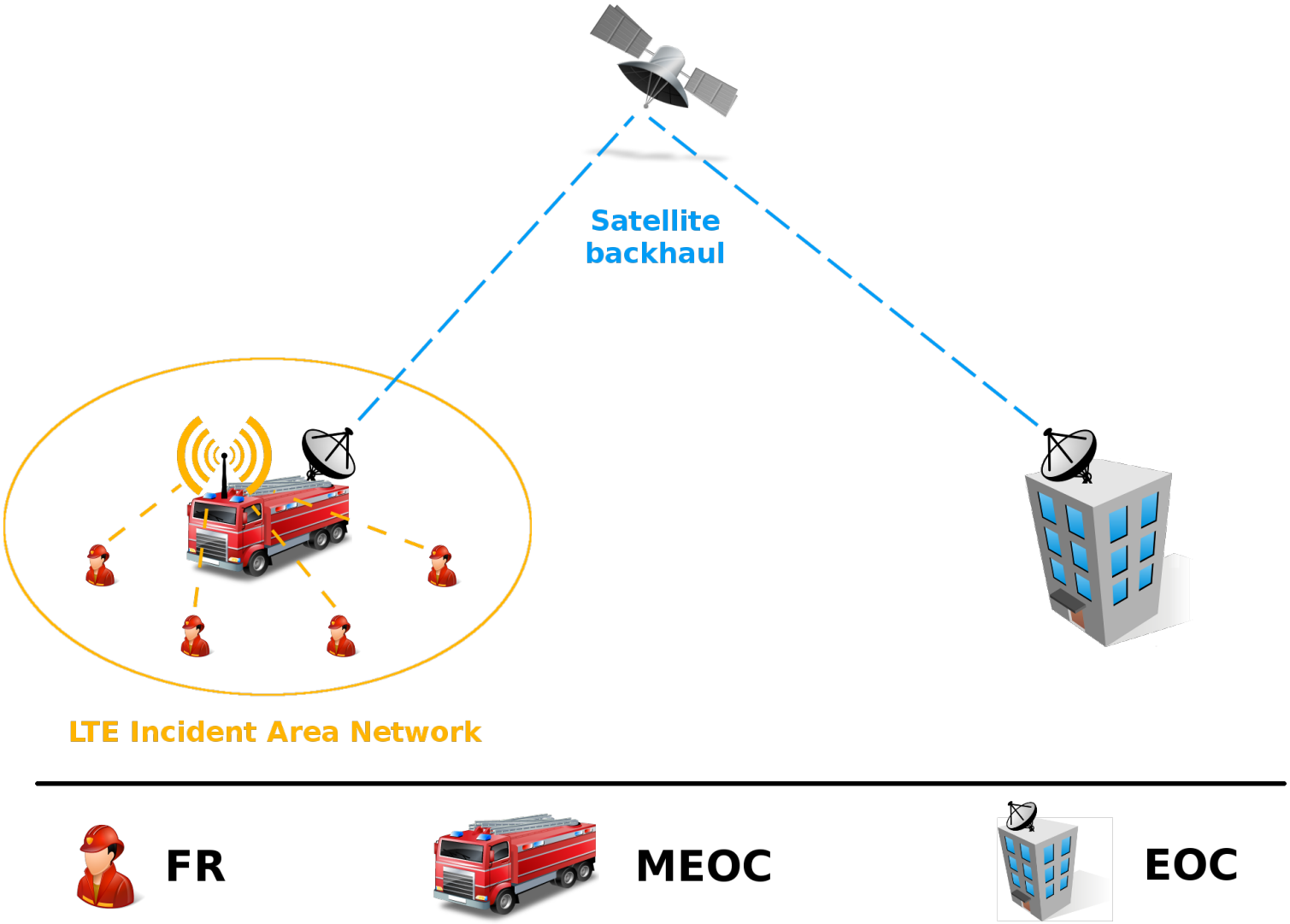
## Performance

We want to provide the possibility to exploit data-intensive applications

## Accessibility

We want the network to be easy to access

# Proposal



# Problem

## Propagation Delay

$$\frac{\textit{link length}}{\textit{propagation speed}}$$

- *propagation speed*: speed of light ($\sim$ 300000 km/s)
- *link length*: $\sim$ 35700 km above the Earth's equator (GEO)

That results in **at least** 250 ms only for propagation delay
In reality, RTTs are usually higher than 600ms!

## High Delay Link and TCP

If reliable transmission is needed, standard TCP protocol performs badly in these conditions

# TCP solution for high-delay links?

## TCP NewReno

Standard TCP, performs well in wired networks, performs bad in wireless, high delay links

## TCP HighSpeed

Designed to mitigate the problem through a very aggressive congestion window growth, unfair when coupled with other TCP flows

## TCP Cubic

Designed to offer balanced performance in every case

## TCP Noordwijk

Specifically designed for satellite links, it is based on different assumptions than the other TCPs

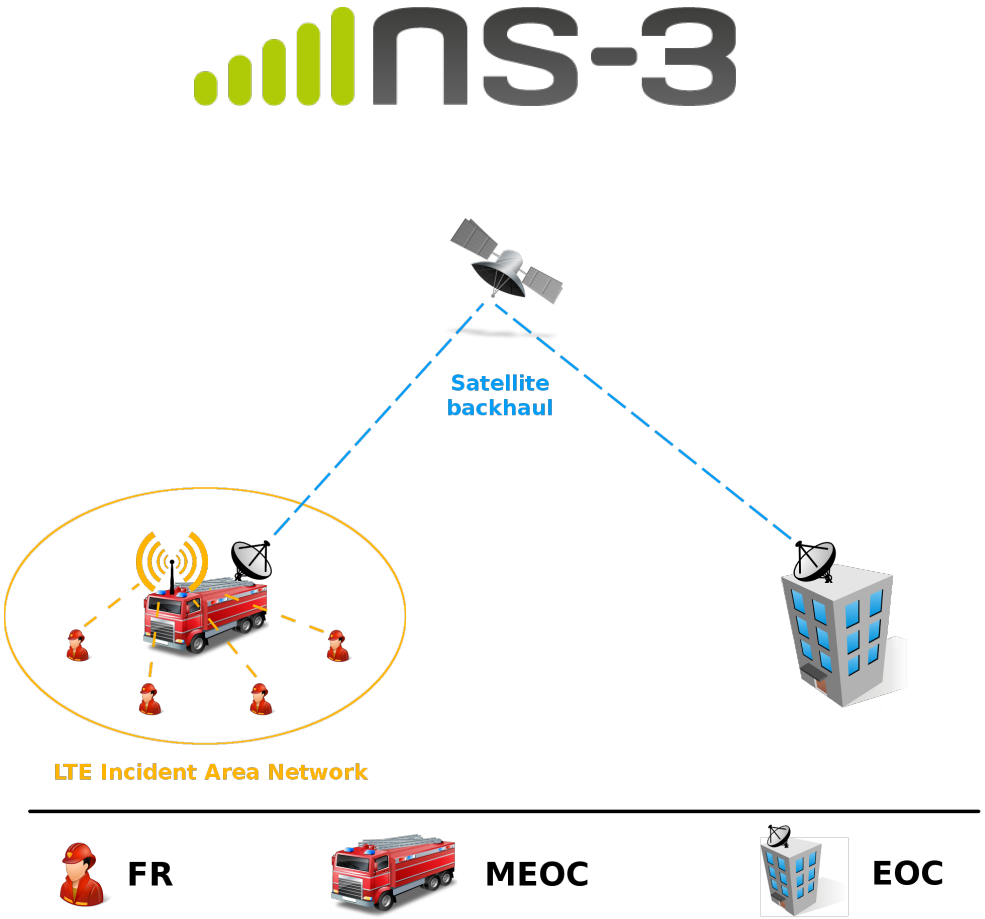
# Simulations


We implemented in ns-3:

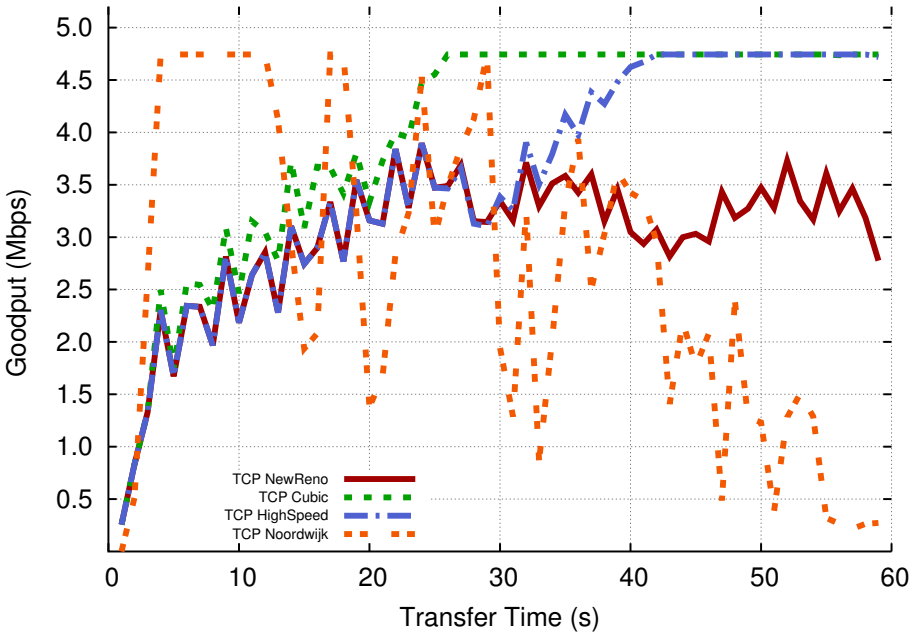
- Network topology
- TCP HighSpeed module
- TCP Cubic module
- TCP Noordwijk module
- TCP Window Scale Option module

# PPDR case study

- LTE BandWidth: 25Mbit/s
- Satellite Link: point-to-point with 5Mbit/s and 300ms
- TCP MSS of 1000 bytes
- TCP: Initial CW 4MSS, SSThr 20MSS
- TCPN: Initial Burst 20MSS, Initial TxTimer 500ms
- 24 FRs involved:
  - 8 FRs send TCP data to EOC
  - 16 FRs send each other UDP data (VoIP, VIP) through MEOC

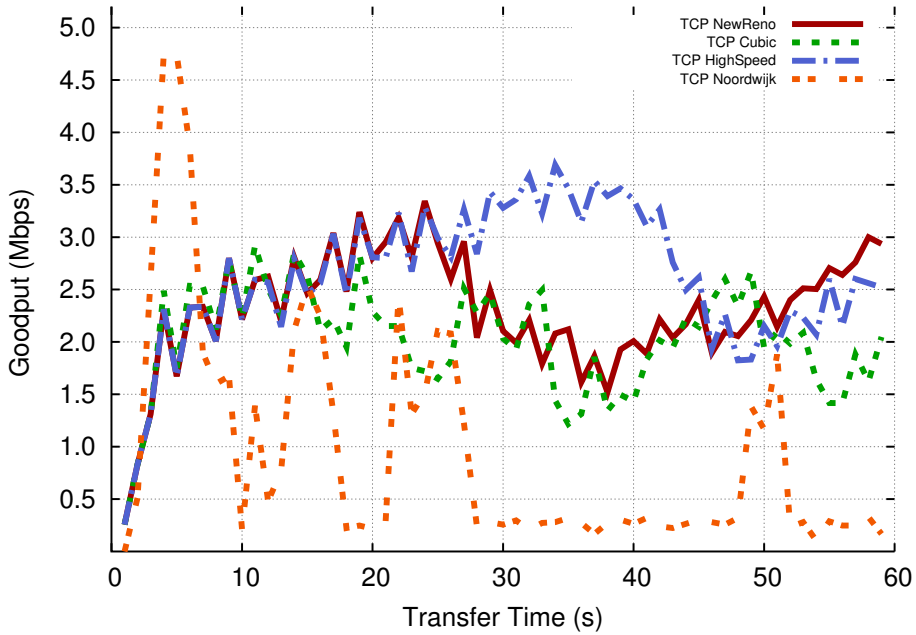


# Simulation Results: Goodput for different TCP algo solution




*Normal conditions*

*8 TCP flows FR ↔ EOC*



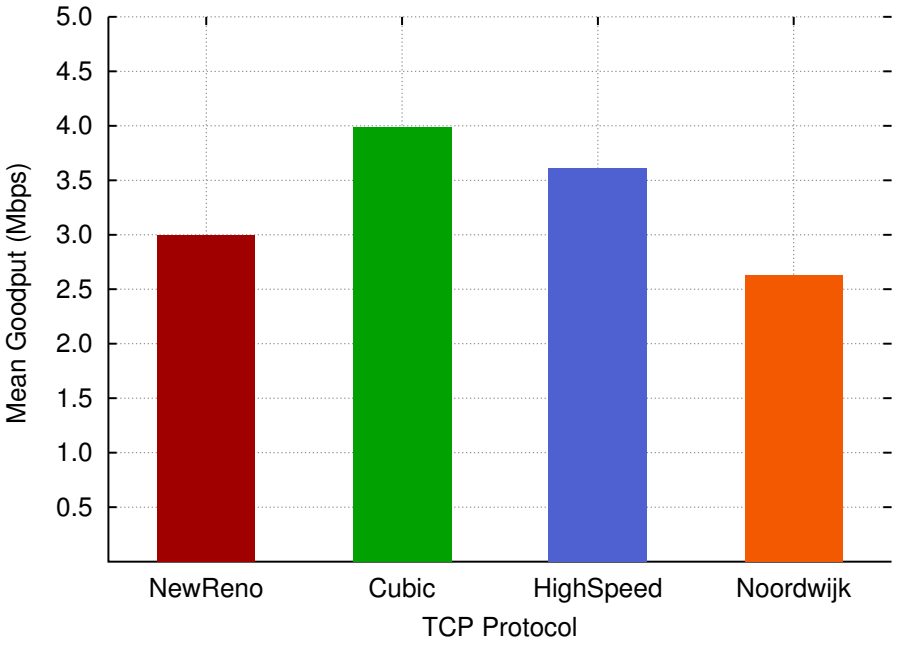

*Under congestion*

*8 TCP flows FR ↔ EOC*

*+*

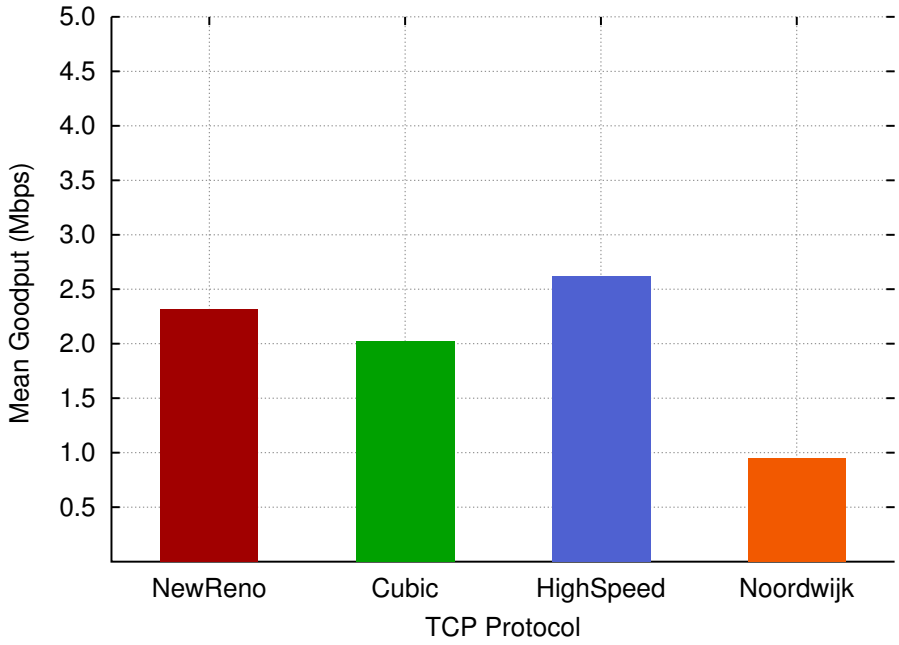
*16 UDP flows FR ↔ FR*

# Simulation Results: Cumulative Goodput




*Normal conditions*

*8 TCP flows FR ↔ EOC*




*Under congestion*

*8 TCP flows FR ↔ EOC*

*+*

*16 UDP flows FR ↔ FR*

# Final Conclusions

## Summarize the Contributions

- Reference Architecture:
  - Deployable and effective
  - Easily accessible
  - Resilient with almost ubiquitous coverage
- TCP investigation:
  - ns3 implementation of several solutions
  - highlighted weakness of TCPN
  - PPDR case study enhanced TCP HighSpeed good performance:
    - Quasi-optimal performance in non congested conditions
    - Best performance during congestion

# Future Works

## Highlighted issues

- Poor performance due to losses
- Buffer losses, not channel losses
- High buffer usage!
- Increase buffer size $\rightarrow$ queueing delay even higher than 10s

## Proposed solution

- Centralized congestion control middleware
- Act in the satellite gateway
- Reduce buffer usage and latency while increase goodput

**Preliminary results will be presented at GLOBECOM'14**

thank you
for your attention

carloaugusto.grazia@unimore.it