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

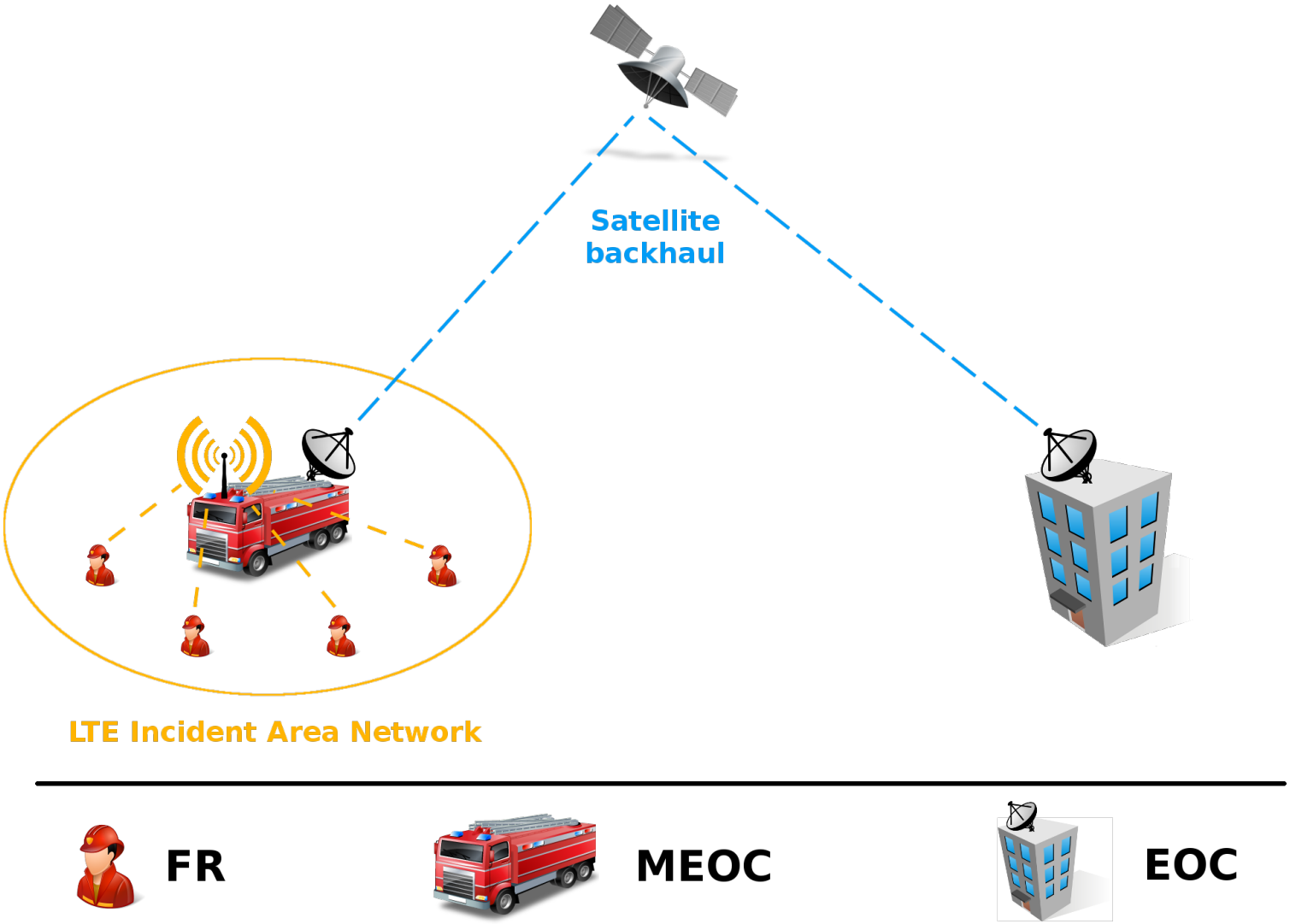
Performance

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

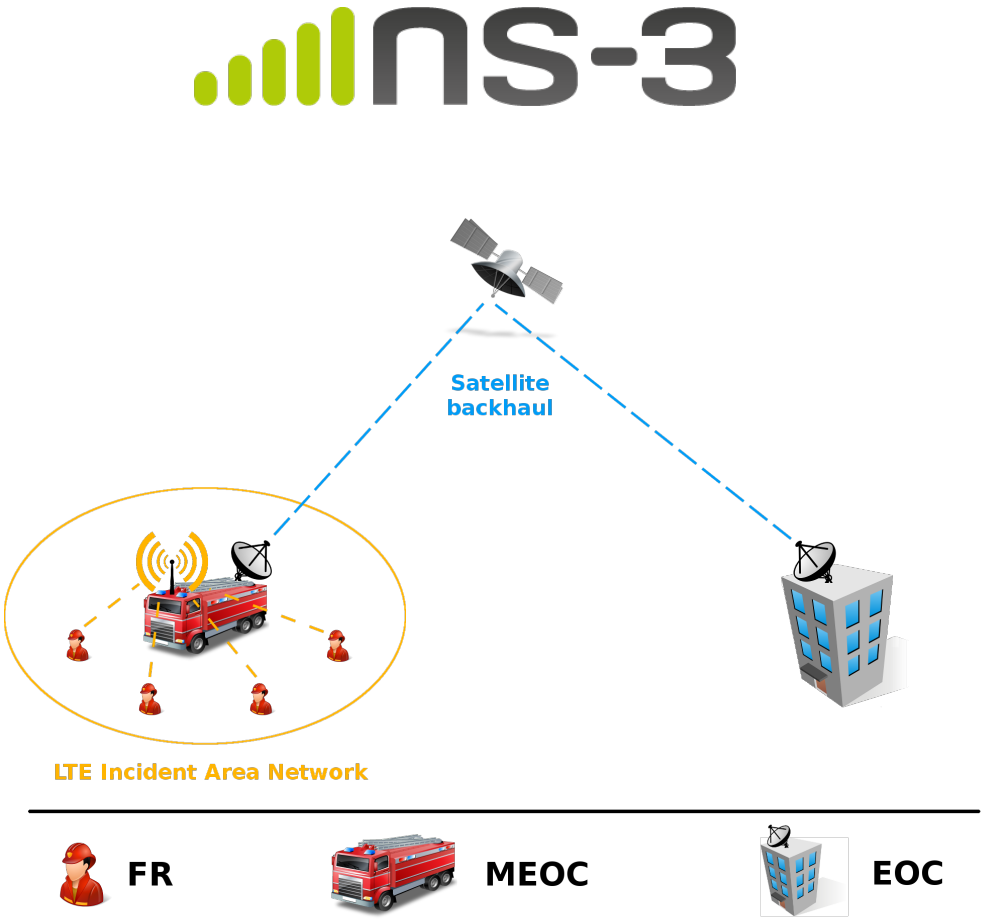
Simulations

We implemented in ns-3:

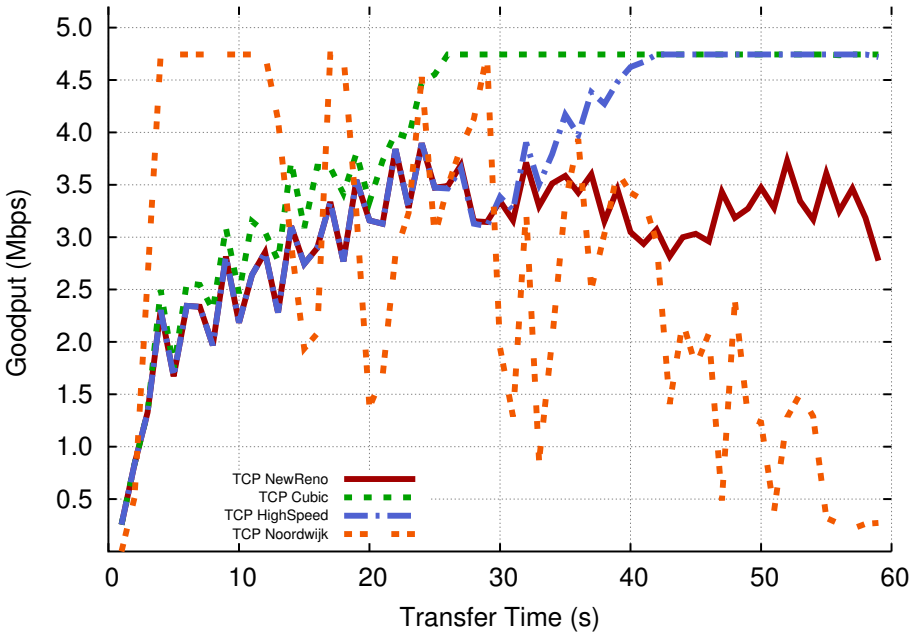
- Network topology
- TCP HighSpeed module
- TCP Cubic module
- TCP Noordwijk module
- TCP Window Scale Option module

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

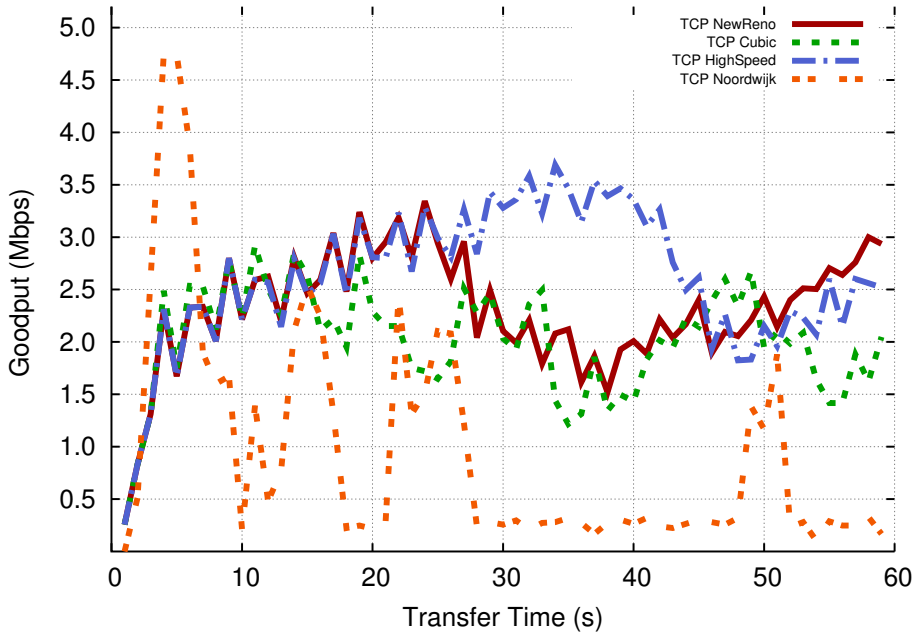


Simulation Results: Goodput for different TCP algo solution



Normal conditions

8 TCP flows FR ↔ EOC



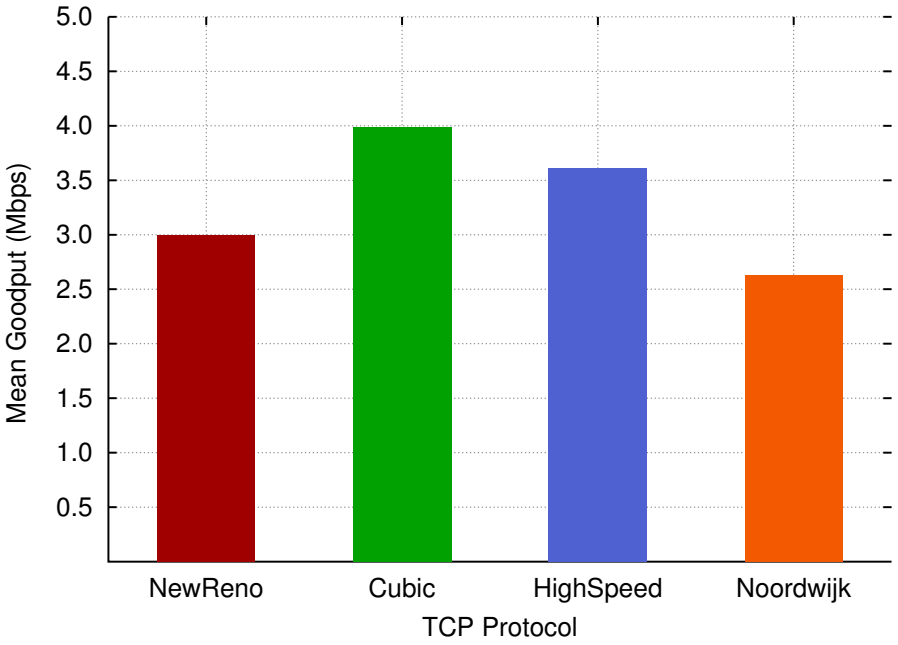
Under congestion

8 TCP flows FR ↔ EOC

+

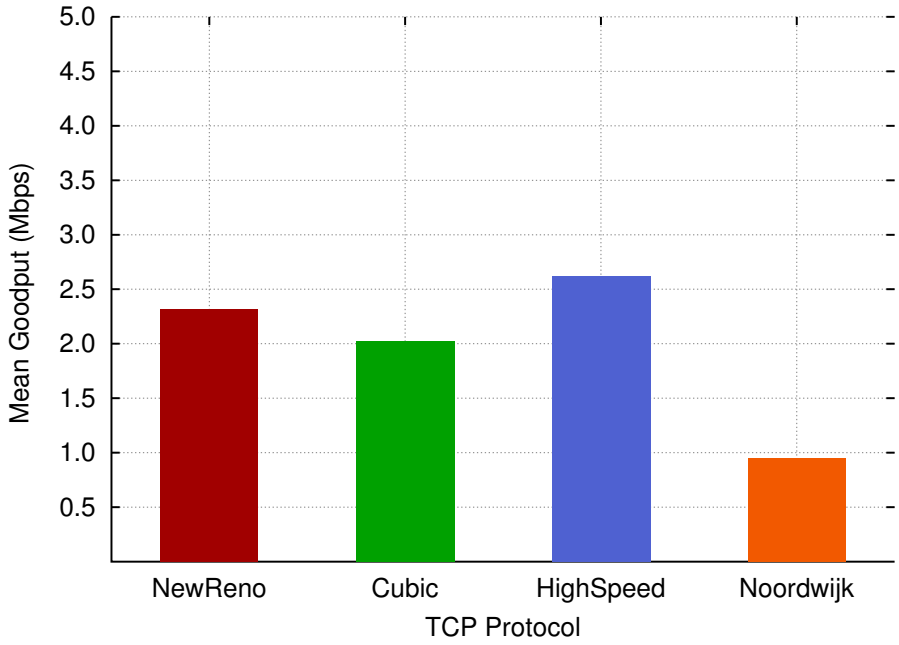
16 UDP flows FR ↔ FR

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