Service Function Chaining in Wildfire Scenarios

Bruno Sousa, Henrique Silva, Noé Godinho, Marilia Curado
University of Coimbra, CISUC, DEI, Portugal

Noé Godinho, 4 February 2022

Outline

- Motivation

- Chaining functions of Mission Critical Services

- Evaluation

- Some Results & Current Steps

Scientific Motivation

- Critical missions (e.g., Fire Fighting) include several services

  - Require availability of communication infrastructure (e.g. SLA 99.9%)

  - Strong security mechanisms (ideally cross-layer perspective)

- Mission Critical Services (MCS):

  - Voice Push to Talk (PTT)

  - Voice Full Duplex (FD)

  - Data Services for Location and IoT data (biosensors, environmental)

  - Multimedia (video streaming for accurate situational awareness)

  - Mission Analysis (Processing collected data to detect hazard events like Man Down)

Motivation for Service Function Chaining

- Security for Mission Critical Services:

  - To work in a technology agnostic fashion (5G, WiFi 6, LORA, etc)

  - Can be enabled with Service Function Chaining (SFC):

    - Intrusion Detection and Prevention (IDPS)

    - Firewall

    - Authentication, Accounting and Authorisation (AAA)

  - Considering diverse deployment options (edge, cloud/centralised)

Service Function Chaining for MCS

- Each Mission Critical Service is:

  - Considered per the criticality and current services in Public Mobile Radio

  - Modelled with several functions with different complexity

  - Deployed in distinct NFV approaches:

    - One VM per service (approach A)

    - One VM per service function (approach B)

Approach	Description	#VMs
A	One VM per service	6
B	One VM per SF	15

Service	Service Function (SF)	Description	Comp. cost (MIPS)
Voice PTT	Vo_conf	Conf. voice channels	[1, 30]
	Vo_chan	Voice bridge & channels	[10, 50]
	Vo_core	Voice core, record & log	[10, 50]
Voice FD	VoFD_down	Voice bridge & channels from CCC to FR	[10, 50]
	VoFD_up	Voice bridge & channels from FR to CCC	[10, 50]
Loc. Data	LocData	GPS location data	[1, 10]
	LocData_map	Map location data	[10, 20]
IoT	IoT_acq	Data acquisition from biosensors, sensors	[1, 10]
	IoT_proc	IoT data processing	[10, 20]
	IoT_ana	IoT analysis - risk maps	[20, 40]
Multimedia	Vid_conf	Video conf. (e.g. groups)	[10, 50]
	Vid_ana	Video real-time analysis	[700, 2000]
	Vid_trans	Video transmission	[50, 200]
Security	FW	Firewall & AAA	[20, 100]
	IDPS	IDPS	[50, 150]
Mission Analysis	SF_Mis_ana	Mission analysis	[10, 200]
	Mis_sndData	Upload data to cloud	[20, 40]

Service Function Chaining Policies

- Devised to avoid unnecessary processing at intermediate layers:

  - Reduce end-to-end latency

  - Maximise operation time in the Operational Theatre

- Consider the node location (and mapping to OpenFog layer):

  - Vehicles for combat and with water tanks, nodes at the field, assure the edge layer (do not include configuration functions, or analytics)

  - Vehicles with communication facilities, nodes at intermediate and CCC layers (include mission analysis functions for real-time risk assessment)

Evaluation

- Simulation based using CloudSimSDN

- Scenario Complexity modelled as phase 1 (with few vehicles and first responders)

- Consider characteristics of LTE and WiFi for bandwidth and delay for links

- Consider two types of platforms with computational resources (Cisco and Raspberry Pi)

- Evaluation metrics:

  - Utilisation of resources (in hosts and VMs)

  - Energy consumed

  - VM bandwidth utilisation

  - Link utilisation

  - CPU time and network time of SFs

Service	Inter Arrival	Packet Size	Computational Cost (PI / Cisco)
Voice PTT	30s	[20, 200]	±1017 / ±1019
VoiceFD	45s	[20, 200]	±1017 / ±1019
LocData	2s	[36, 100]	±511 / ±512
IoTData	5s	[8, 500]	±2535 / ±2540
Multimedia	60s	[250, 1300]	±6583 / ±6596
MissionAna	120s/ 600s	[1000, 1500]	±7595 / ±7610

Results: Host and link utilisation

- The Cisco platform has higher utilisation (lower CPU clock)

- LTE has higher utilisation rates

- Uplink traffic leads to higher utilisation (flows are generated from FRs in the field)

Host utilisation

DownLink utilisation (from CCC to FR)

Uplink utilisation (from FR to CCC)
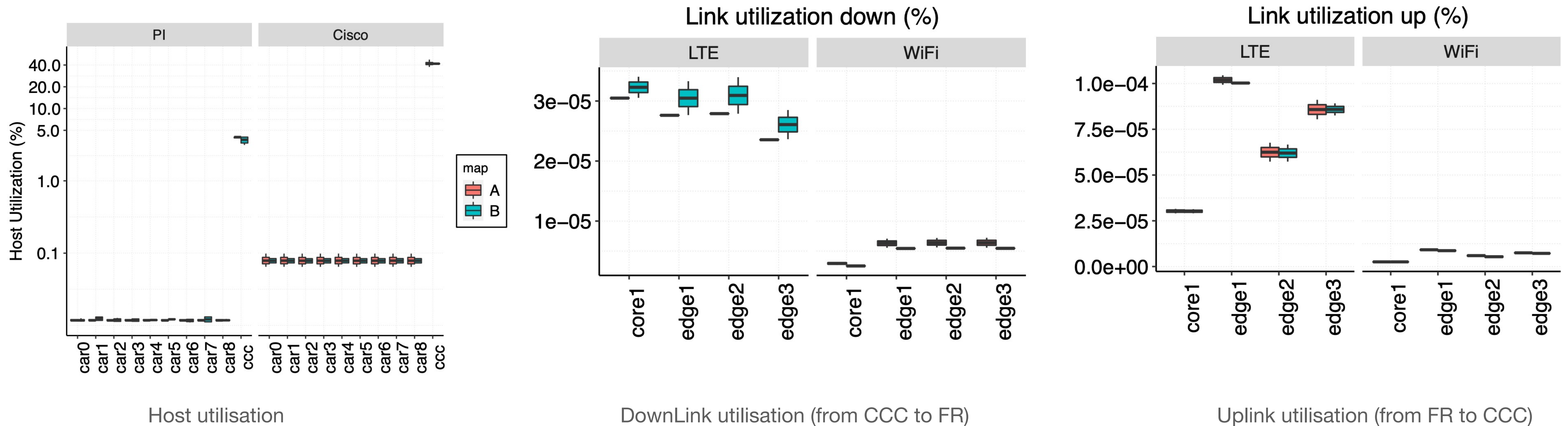
Conclusion & Current Steps

- SFC in MCS need to optimise the placement of security functions

- The platform to support edge (at cars) needs to be carefully chosen

- SFC in MCS are also impact with the direction of flows and the characteristics supporting technologies.

Currently:

- We are studying the impact of Migration algorithms (distance and mission-related)

- We are considering the complexity of the full operational theatre (phase 5 with more than 1000 human resources)

Thank you

Additional questions
bmsousa@dei.uc.pt