



Future Summits 2022

Fast-Forward into the Tech Future



Wireless time-sensitive networking

Demanding time-sensitive applications

≡○ = motion

		1ms	5ms	10ms	20ms	100ms
INDUSTRY 4.0	AGV/cranes ≡○			kbit/s - Mbps		
	Functional safety	kbit/s				
	Condition monitoring				kbit/s	
	Closed loop control	kbit/s / < 20us jitter				
	PLC/robot ≡○	< 100kbps				
AUDIO/VIDEO /HAPTICS	Live performance	0.150–4.5Mbps / #300				
	Presentation		0.15–1Mbps / #10			
	Tour guide		150-350kbps / #10 – MC #100			
	Haptics	< 1Mbps / 0.2-2ms jitter				
	AV conferencing		kbps (audio) – Mbps (video)			
AR/VR	Entry-level WI			60Mbps		
	Ultimate WI	Deep immersion	2.34Gbps			
	Entry-level SI		120Mbps			
	Ultimate SI	3.36Gbps				

Latency / cycle time

E2E latency inc. processing

RTT for comm.

Time-Sensitive Networking (TSN)

IEEE 802.1 TSN set of standards to enable
deterministic communication on standard Ethernet



Wireless Time-Sensitive Networking ?

Wireless TSN - Challenges



Synchronization

(Wired-wireless) scheduling



Verification

Bootstrapping



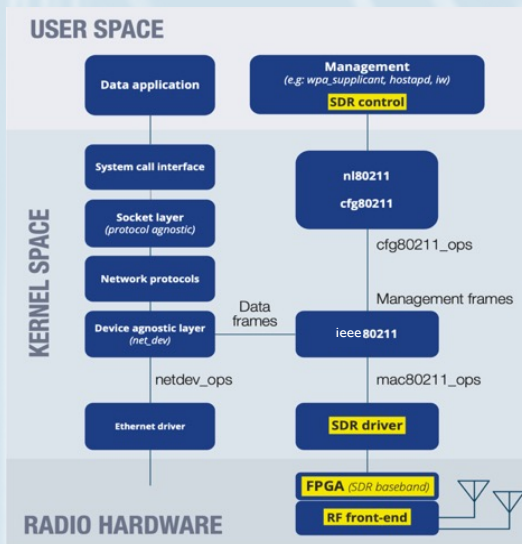
App-Net integration

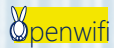
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Wireless Time- Sensitive Networking

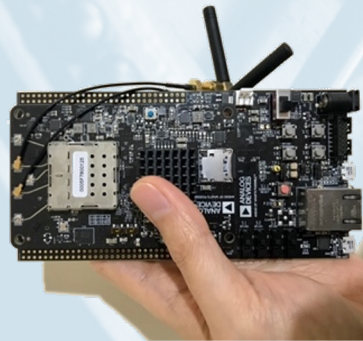


World's first free WiFi open chip design

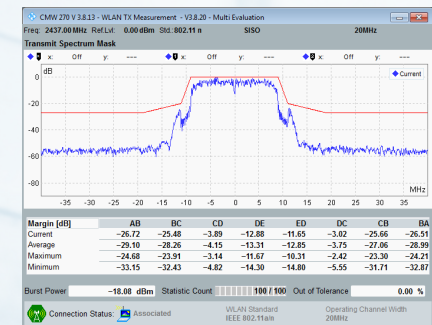
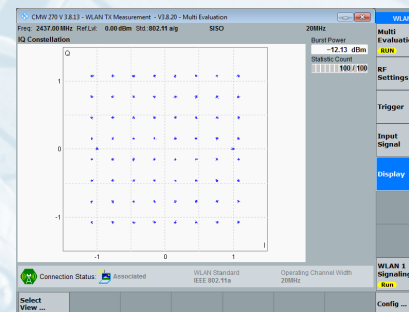
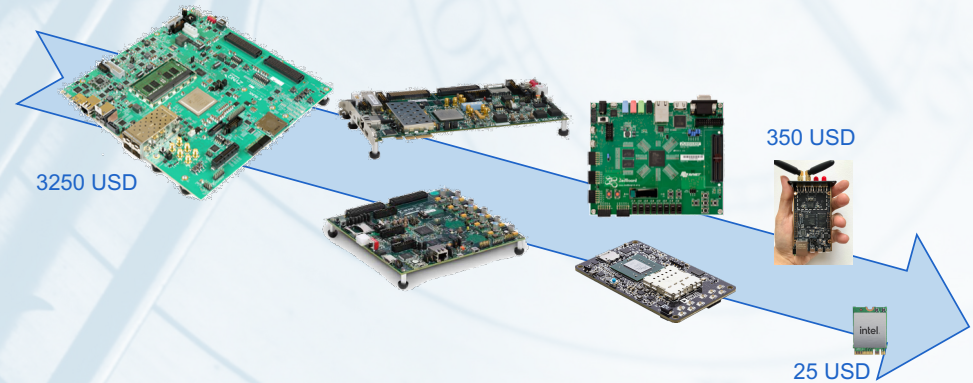


Linux native 

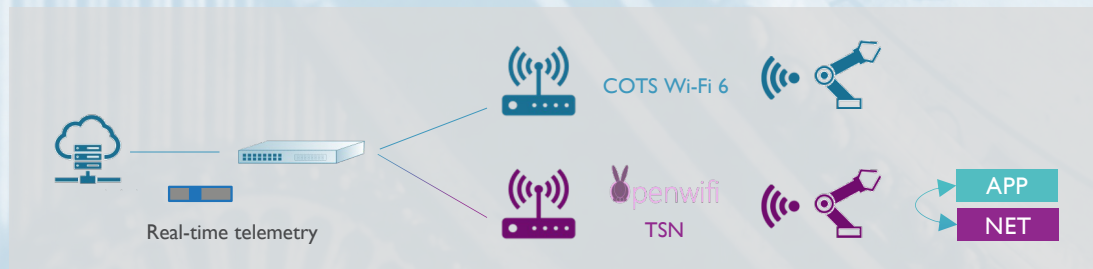
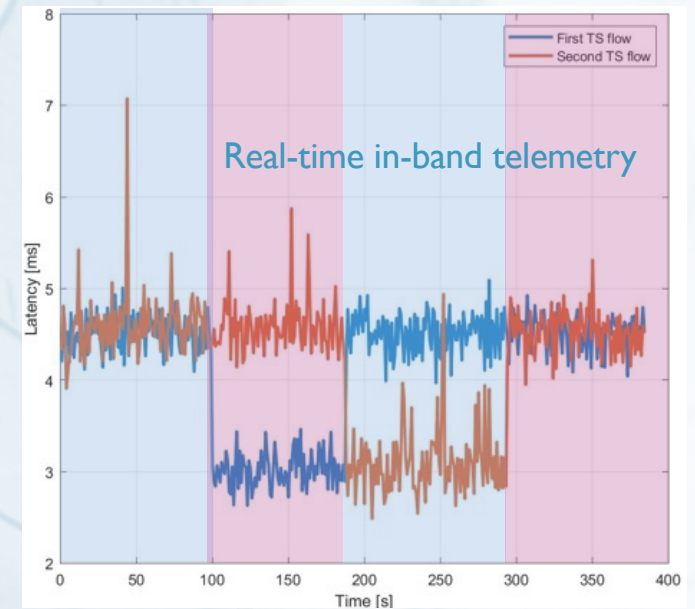
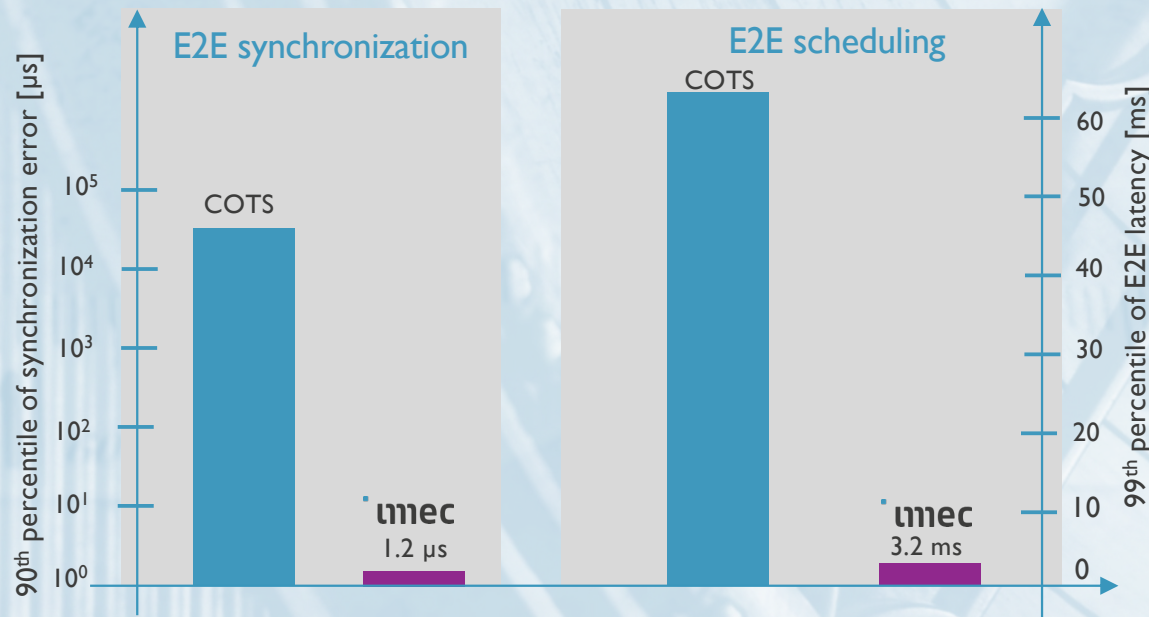
 Openwifi



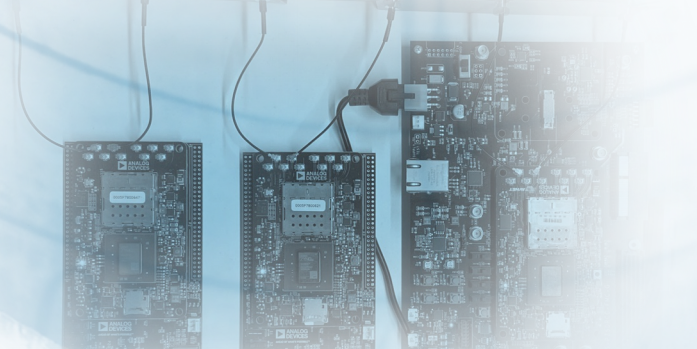
<https://github.com/open-sdr/openwifi>



+ unique W-TSN extensions



Real-time schedule distribution



W-TSN Evaluation Kit



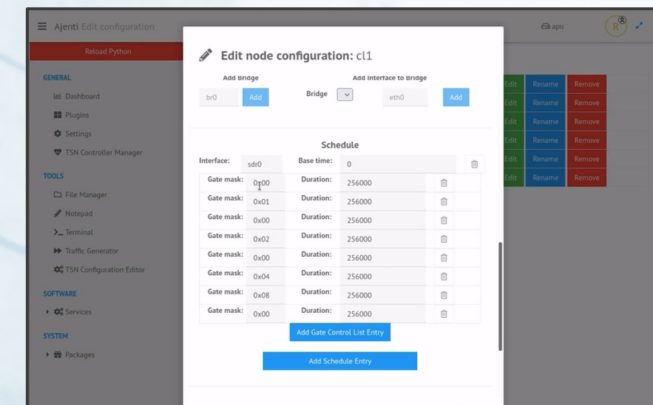
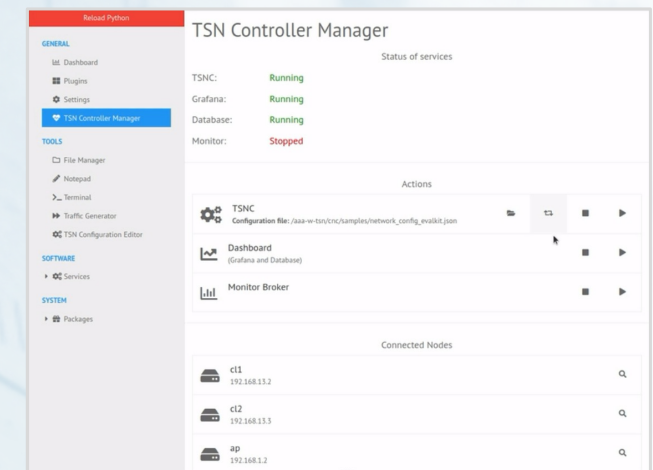
Wireless: imec's Linux mac80211 compatible full-stack Wi-Fi supporting 802.11a/g/n, 20MHz bandwidth, AP/STA/ad-hoc mode, DCF (<https://github.com/open-sdr/openwifi>)

Synchronization: imec's openwifi HW timestamping, linuxptp for sync accuracies $< 1.4 \mu s$

Scheduling: 802.1Qbv wired scheduling, imec's 802.1Qbv extension for openwifi access point and clients with 4 HW queues, cycle lengths from 512 to 65636 μs , slot lengths from 128 to 16384 μs

Monitoring: imec's real-time in-band telemetry

Control: imec's central controller for management, end-to-end scheduling, visualization of monitoring data





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