

Examples of Radio Environment in the Factories

Date: 2017-11-07

Author(s):

Name	Company	email
Hasegawa, Akio	Advanced Telecommunications Research Institute International (ATR)	ahase@atr.jp
Sugiyama, Keizo	Advanced Telecommunications Research Institute International (ATR)	ke-sugiyama@atr.jp
Ohsawa, Tomoki	BRID Inc.	tohsawa@brid.co.jp
Hasegawa, Jun	Fujitsu Kansai-Chubu Net-Tech Limited	hasegawa.jun@jp.fujitsu.com
Naito, Shoji	Fujitsu Kansai-Chubu Net-Tech Limited	naito.shoji@jp.fujitsu.com
Yamazaki, Hiroaki	Fujitsu Kansai-Chubu Net-Tech Limited	yamazaki.h@jp.fujitsu.com
Nishikawa, Takurou	Fujitsu Limited	nisikawa.taku@jp.fujitsu.com
Sato, Shinichi	Fujitsu Limited	sato_shinichi@jp.fujitsu.com
Kato, Toshio	Mobile Techno Corp.	kato.toshio@jp.fujitsu.com
Tomita, Hisanori	Murata Machinery, Ltd.	hisanori.tomita@koa.muratec.co.jp
Itaya, Satoko	National Institute of Information and Communications Technology (NICT)	itaya@nict.go.jp
Kojima, Fumihide	National Institute of Information and Communications Technology (NICT)	f-kojima@nict.go.jp
Koto, Hajime	National Institute of Information and Communications Technology (NICT)	h-koto@nict.go.jp

Author(s):

Name	Company	email
Mochinaga, Mika	National Institute of Information and Communications Technology (NICT)	m-mochinaga@nict.go.jp
Ezure, Yuichiro	NEC Communication Systems, Ltd.	ezure.yc@ncos.nec.co.jp
Ito, Chikashi	NEC Communication Systems, Ltd.	ito.chk@ncos.nec.co.jp
Kobayashi, Tsukasa	NEC Corporation	t-kobayashi@fa.jp.nec.com
Maruhashi, Kenichi	NEC Corporation	k-maruhashi@bl.jp.nec.com
Nakajima, Taketoshi	NEC Corporation	nakajima@cp.jp.nec.com
Okayama, Yoshimitsu	NEC Corporation	y-okayama@bl.jp.nec.com
Tsuji, Akira	NEC Corporation	a-tsuji@bq.jp.nec.com
Zein, Nader	NEC Europe Ltd.	Nader.Zein@EMEA.NEC.COM
Saito, Keisuke	OMRON Corporation	keisuke@ari.ncl.omron.co.jp
Fujimoto, Takuya	OMRON Corporation	takuya_fujimoto@omron.co.jp
Yamada, Ryota	OMRON Corporation	ryamada@ari.ncl.omron.co.jp
Ohue, Hiroshi	Panasonic Corporation	ohue.hiroshi@jp.panasonic.com
Amagai, Akihiro	Sanritz Automation Co., Ltd.	amagai@sanritz.co.jp

This presentation is

- Second part of kickoff meeting of IEEE 802 Network Enhancements for the Next Decade Industry Connections Activity (NEND) and follow-up of discussions in IEEE 802.1 Interim meeting Sep. 2017.
- There were requests to see example and/or evidence data of wireless communications in factories.

- Introduction of next presentation
- Identify the direction of our scope

Back ground

- There are some applications **to require End-to-End(E2E) reliable and robust connectivity** in the factories.
- However, users would like to use **wireless communications for “last hop”** in their manufacturing systems.
- If there are wireless communications in the systems, it makes difficult to realize E2E reliable and robust connectivity in the systems.



This presentation shares
examples of Radio Environment in the Factories.

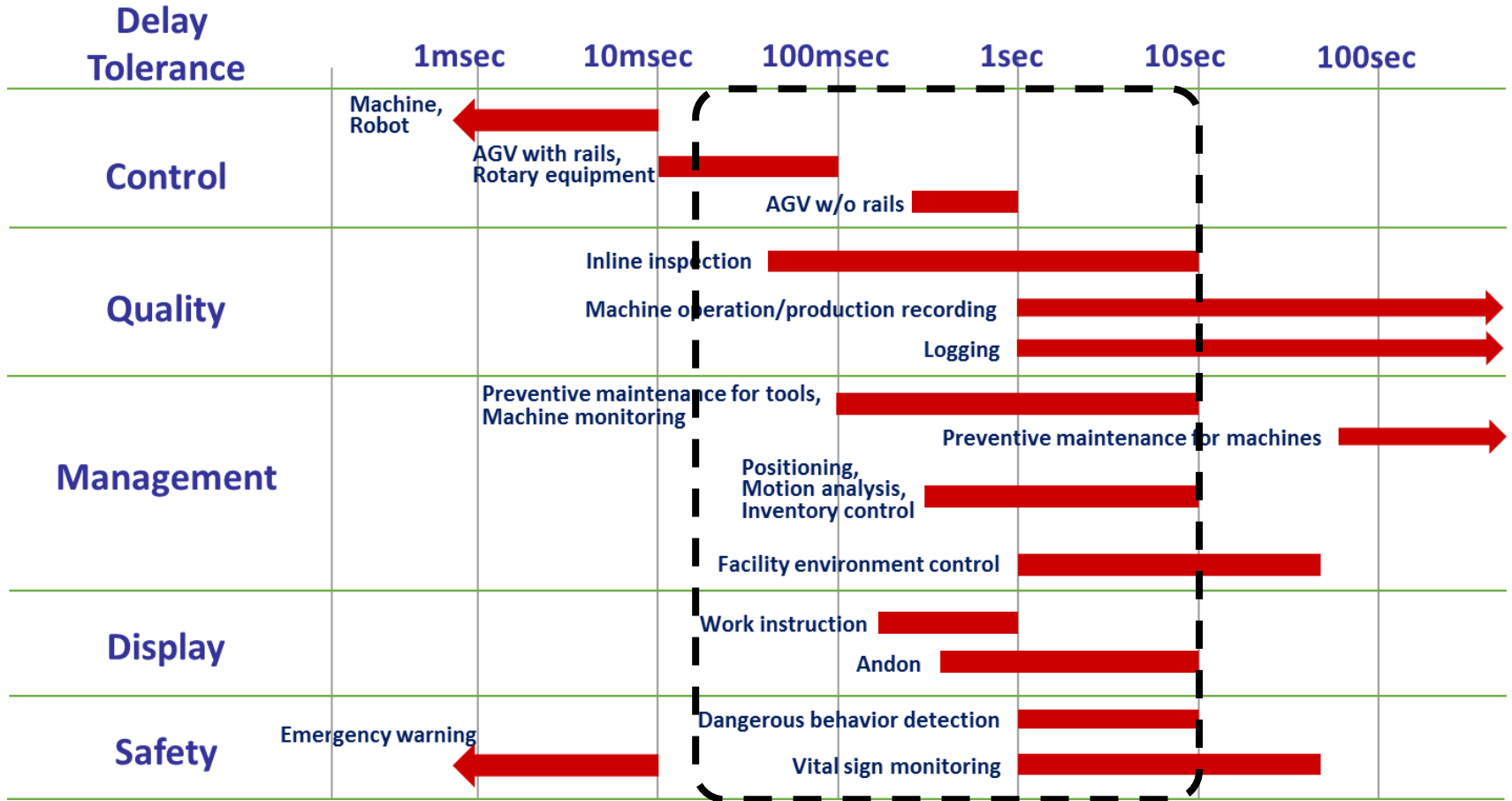
Observations

- We have evaluated wireless environment at several factories in operation and found issues to be resolved.



More Information <https://www.nict.go.jp/en/press/2017/03/01-1.html>

Wide Variety Wireless Applications



Difficult to ensure E2E latency

Our Target

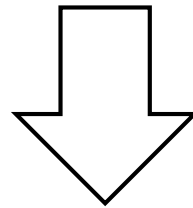
Source: Flexible Factory Project

Problems come from combination of

- A) **Severe Environment** for Wireless Communication
- B) **Uncoordinated** and Independent Systems

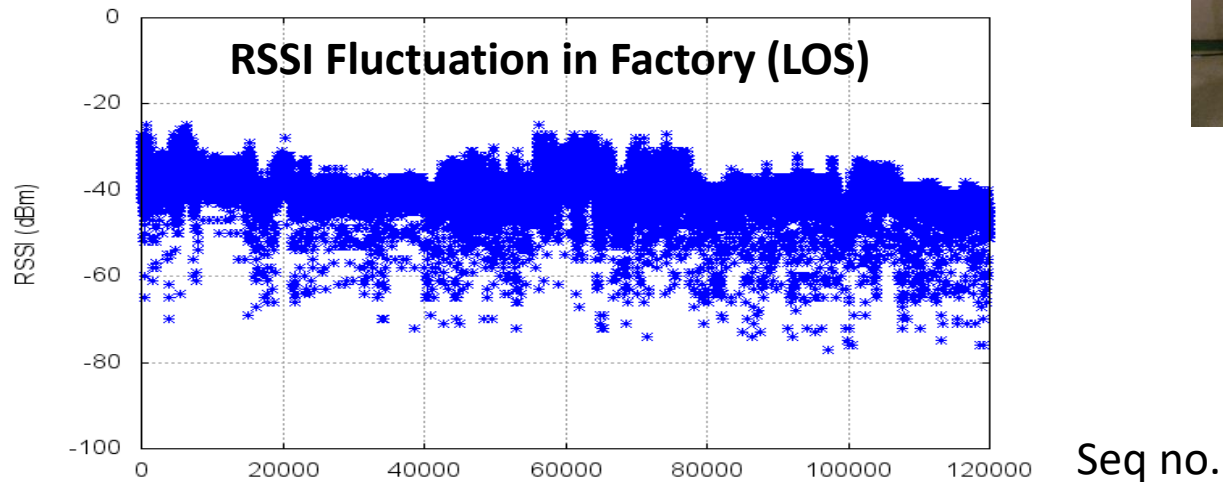
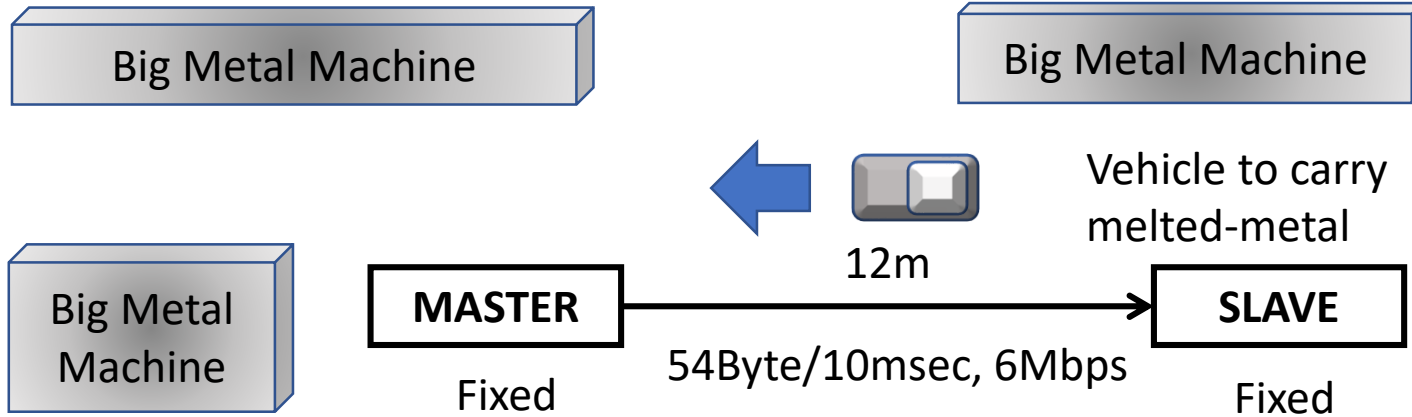
A) Severe Wireless Environment

- ① Fluctuation of Signal Strength
- ② Noises at 1.9GHz and 2.4GHz



Dynamic change of channel capacity

Example①: Fluctuation of Signal Strength



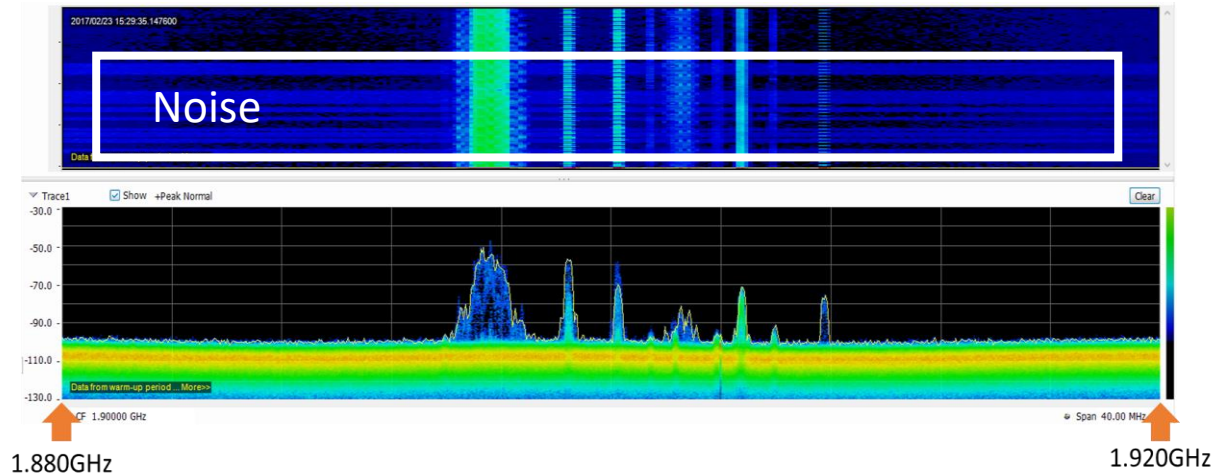
Motions of materials, parts, products, and carriers in a closed space.

Example②:

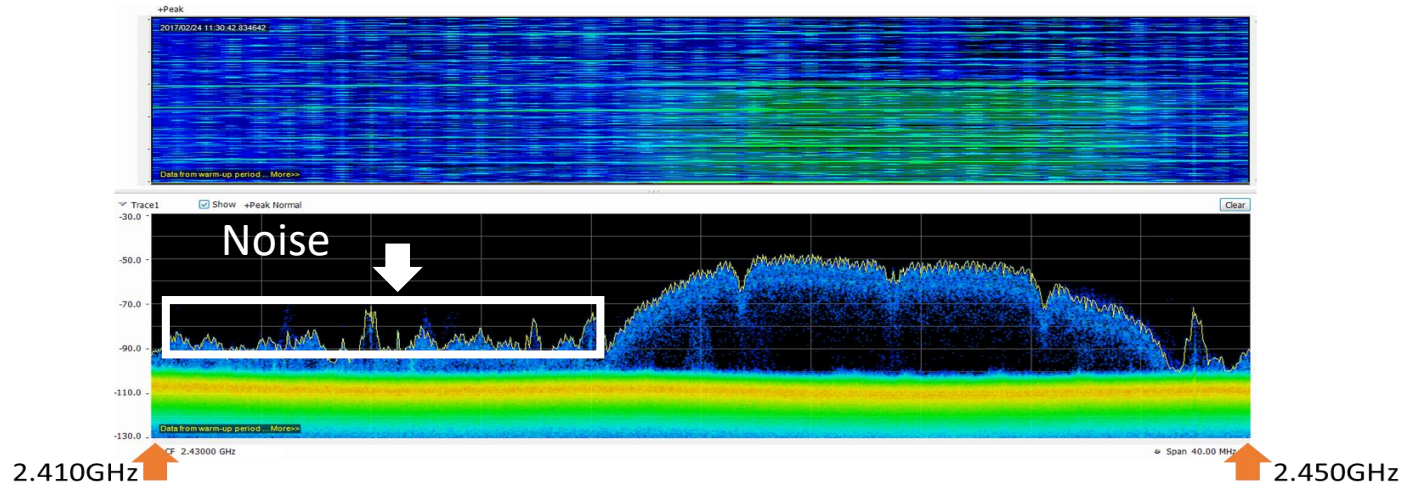
Noises observed at 1.9GHz and 2.4GHz

1.9GHz

Problem: Beside a particular machine, internal tel. using 1.9GHz is not good for communication



2.4GHz

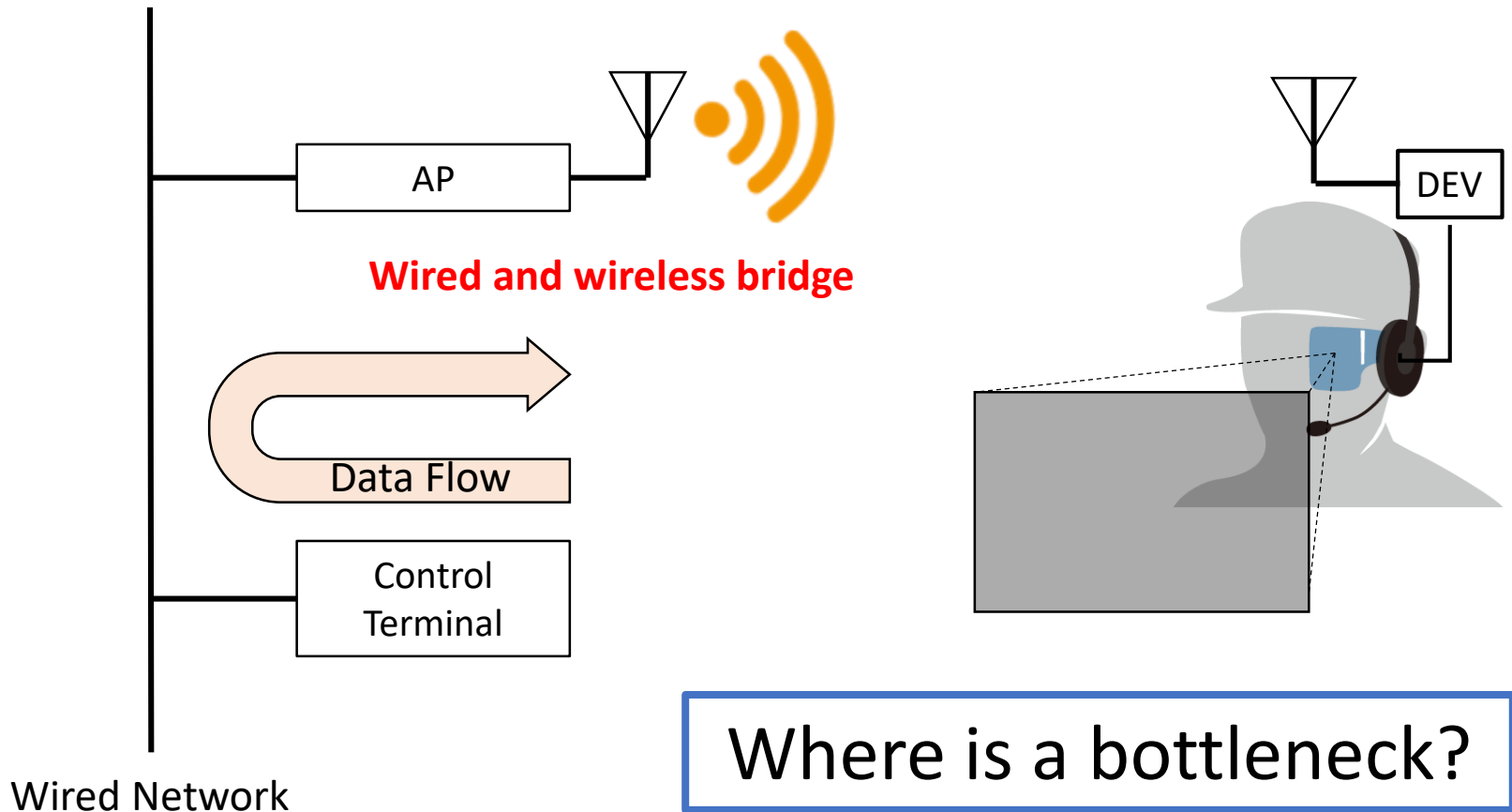


Some kinds of manufacturing machines may be interference sources for wireless communications

B) Uncoordinated Independent Systems

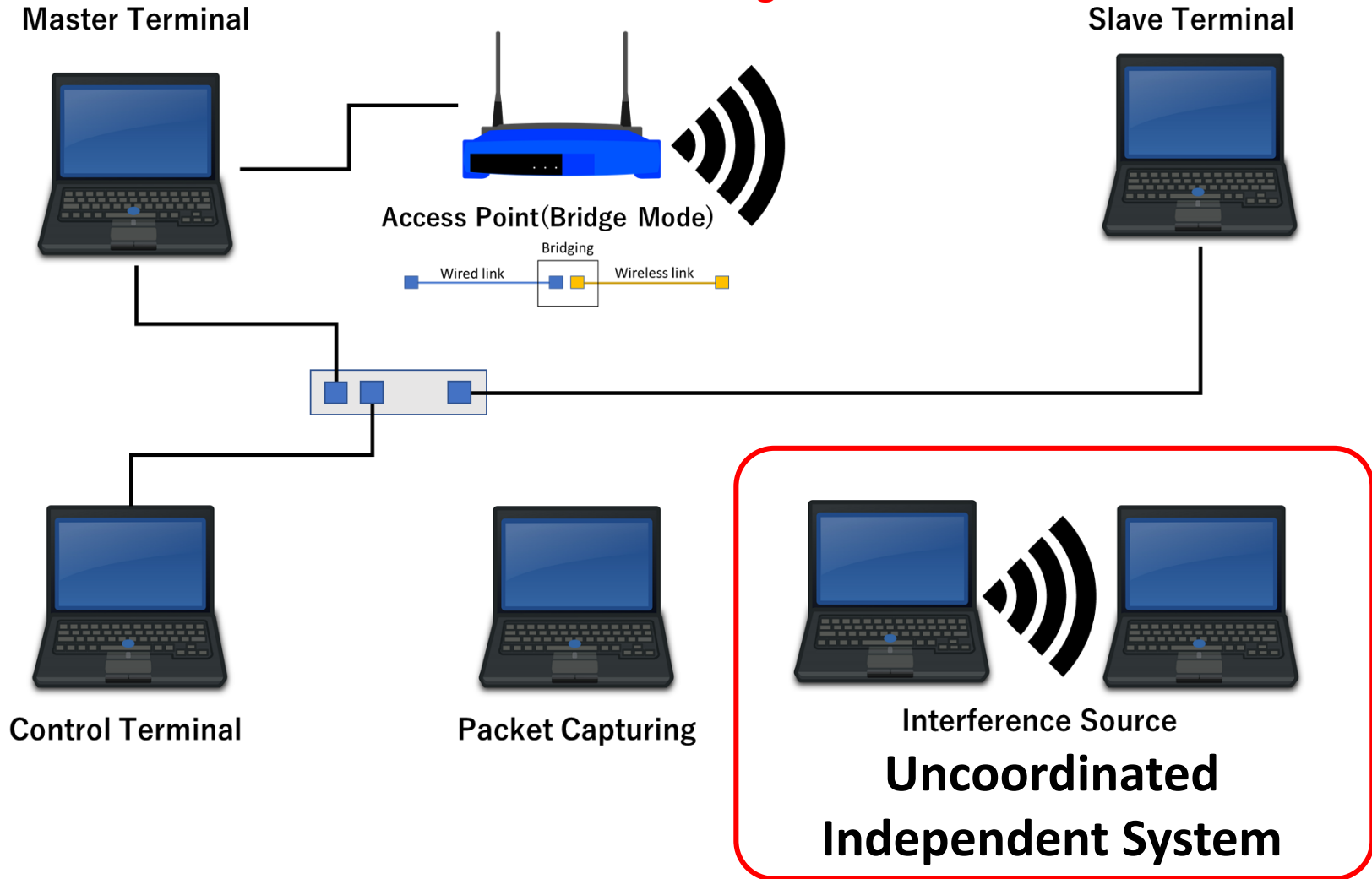
- Step-by-step installation
- Coexistence of heterogeneous and legacy devices/systems.

Scenario of using wireless technology in the factory (one example)



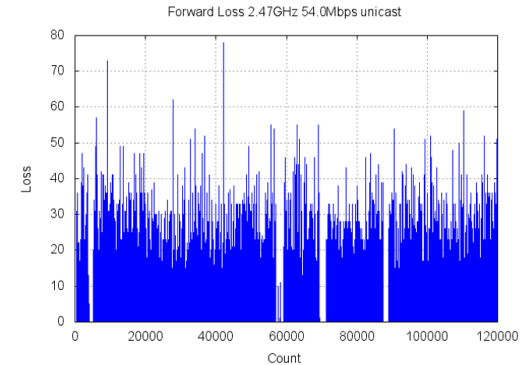
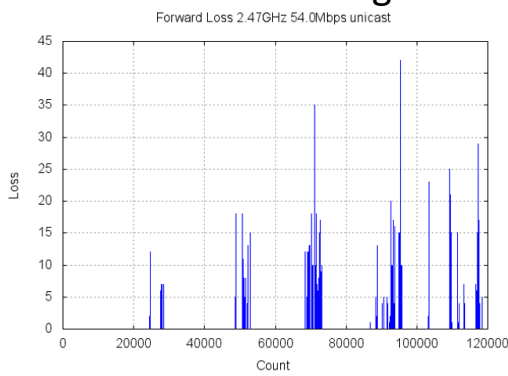
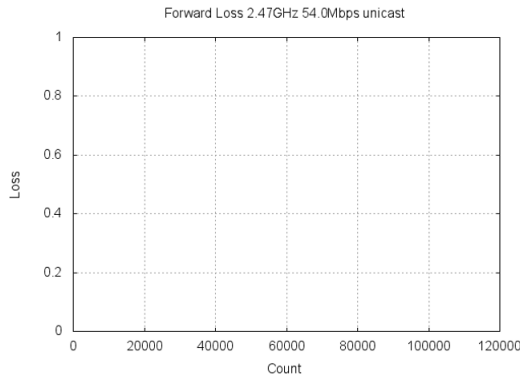
Test System Setup (wi-fi)

Wired and wireless bridge



Coexistence of **uncoordinated** wireless systems bring problems

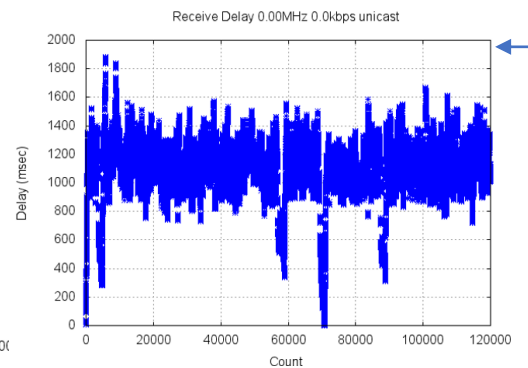
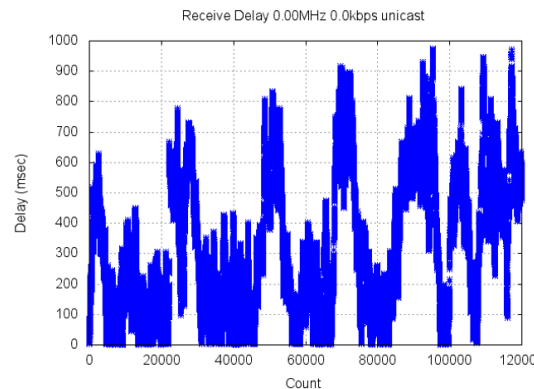
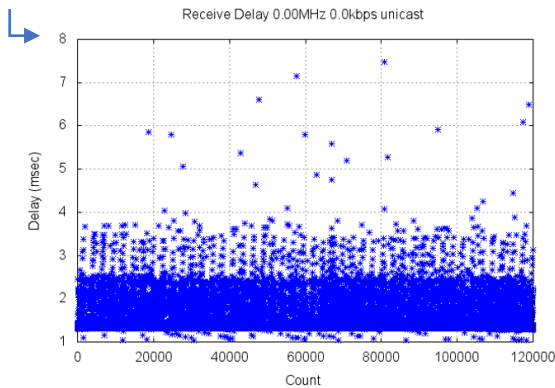
Packet Loss of Bridge Part



Max ~8 msec

Packet Delivery Delay

Max ~2 sec

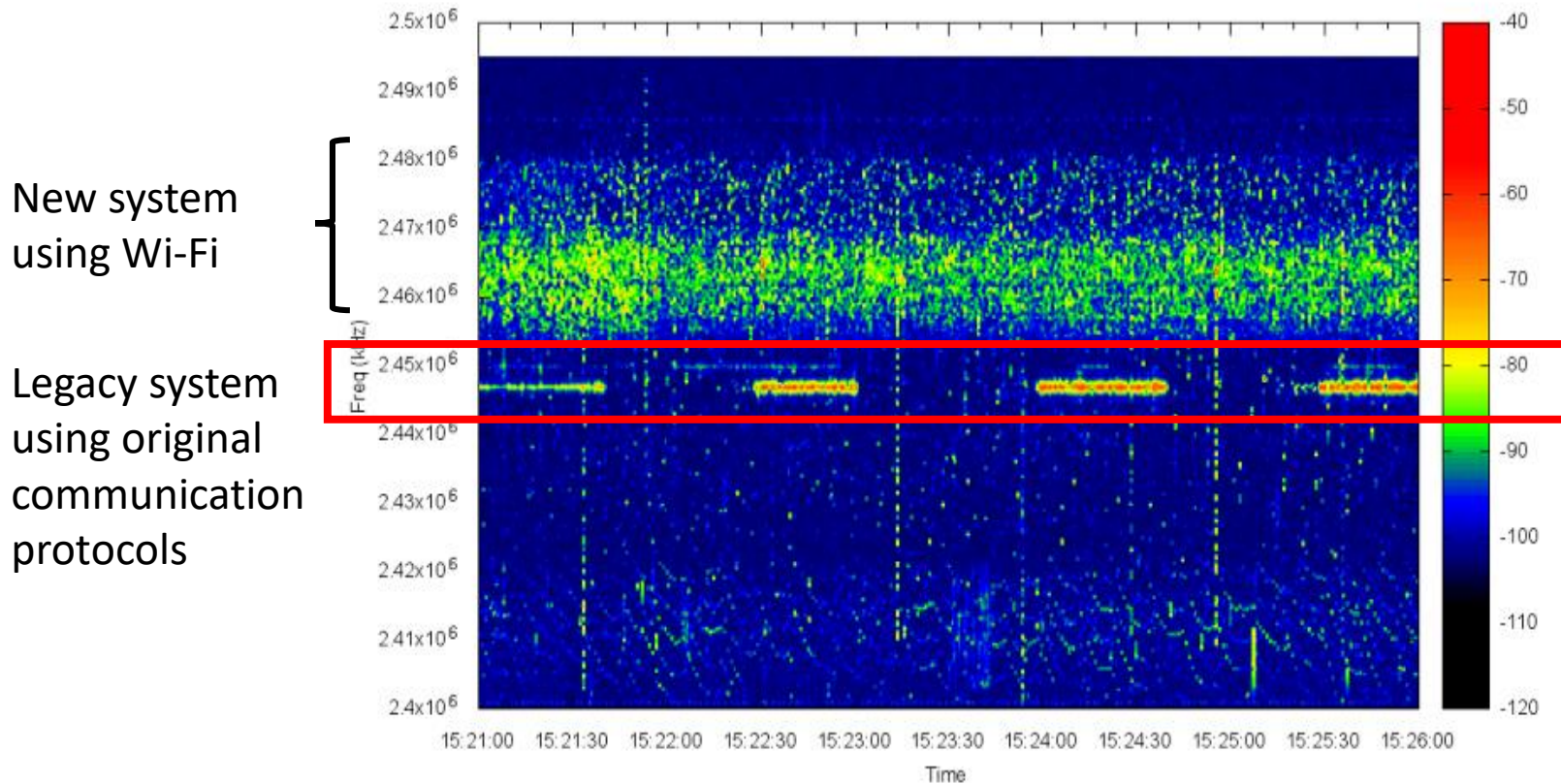


No interference

High Interference

The wireless environment is worsened by Bluetooth, Zigbee, legacy wireless communications, etc.

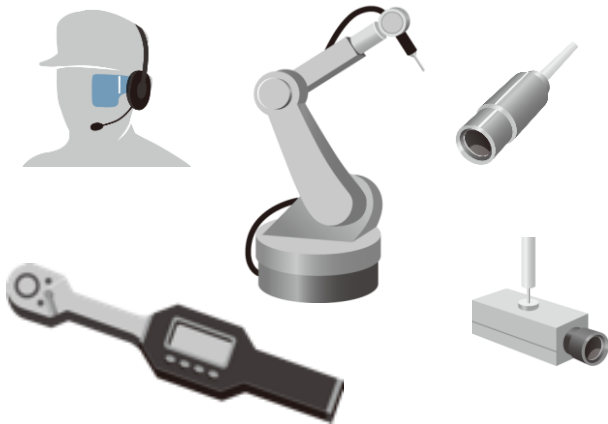
Coexistence of different wireless technologies



Legacy wireless communication does worse to Wi-Fi

Our Motivation

Use Cases

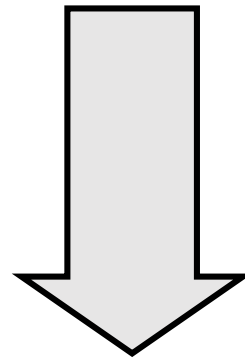


Integration and coordination of multiple streams from different applications

Special Wireless Environment In Factories

- Dynamic change of link capacity
- Not isolated systems, and mixed use of standard technologies in single system
- Interference of heterogeneous technologies

Combination of Independent standard technologies



How to Realize Reliable Systems in Factories?

How to realize reliable systems using wireless communication in the factories?

- From **requirements of applications** and **resource-constrained environments**, we should consider the following combined situations
 - (1) End-to-end(E2E) reliable and robust connectivity required by factory applications
 - (2) Dynamically changing wireless environment
 - (3) Wired and wireless bridge in heterogenous networks

To be continued