Smart Home Audio

2022 Q4 N681389 Product Launch

November 19, 2022

Nuvoton Smart Home Audio Product Offering

Audio CODEC → Audio MCU → Audio DSP → Audio Amplifier

🚗 AECQ100

⬜ AECQ100 in progress

Audio MCU / Audio DSP:
- **User interface**
- **Input processing algorithm**
- **Output processing algorithm**

✓ **Codec (Voice Coder + Decoder)**
✓ **SLIC (Subscriber Line Integrated Circuit)**

Audio Component

Audio Converters
- ADC Mono/2CH/4CH
- Precision ADC
- DAC Stereo/2Vrms
- CODEC Mono/Stereo/ULP

Audio Amplifier
- Class-AB Mono 2W
- Class-D Mono/Stereo 3W
- Power Stage 20W
- Smart Amp

ISD ChipCorder
- Playback
- Rec & Playback

Audio Interface
- 1CH CoSlic
- 2CH CoSlic

Audio SoC

Arm® Cortex®
- ARM M0 I91xxx
- ARM M4 I94xxx

Audio DSP
- Input/Output Processing
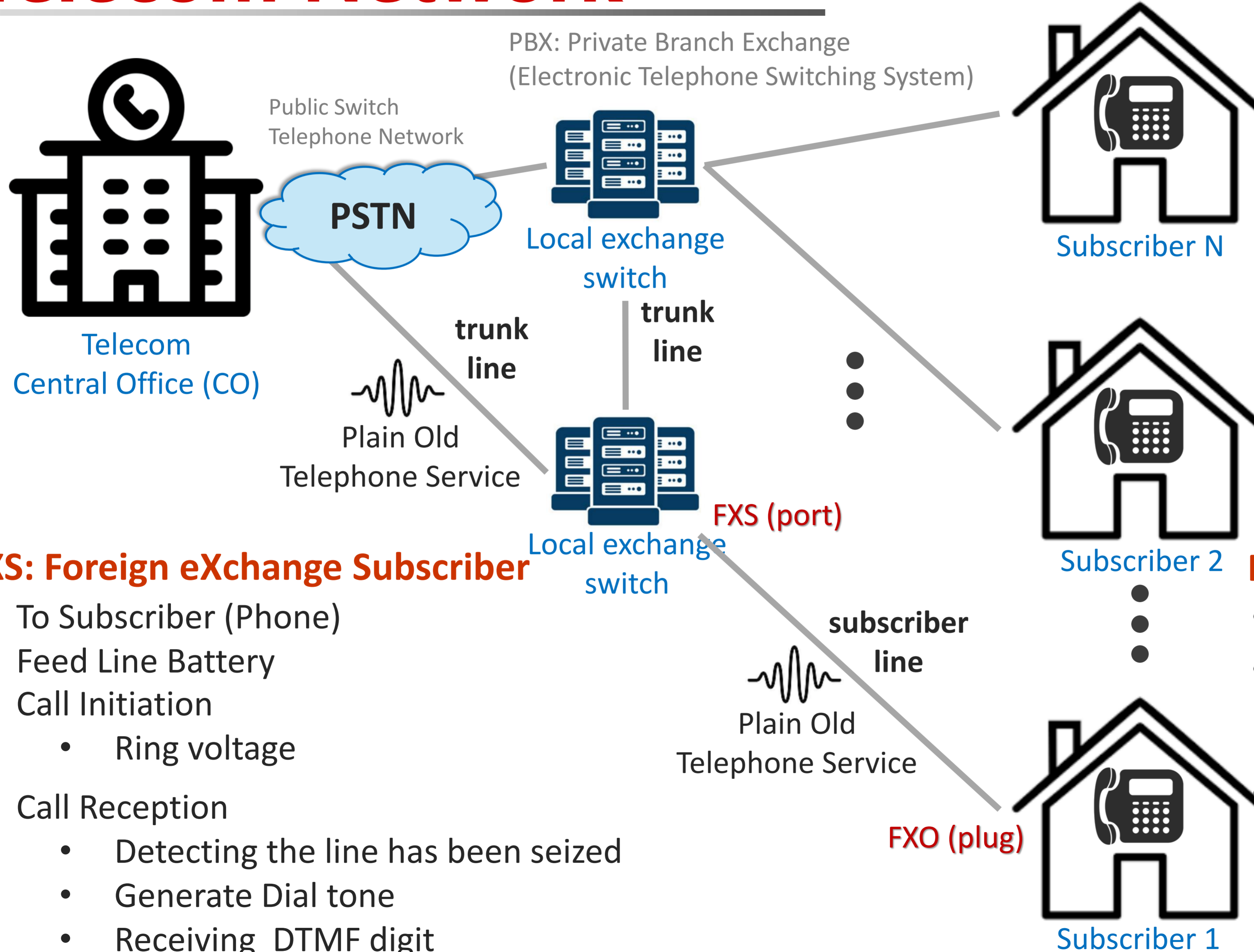- Audio Enhancement

Track Record

- An Automotive Certified Supplier

- More than 1 billion devices sold

- Designed into Fortune 500 companies and market leaders – Automotive, Computing, Industrial, Consumer
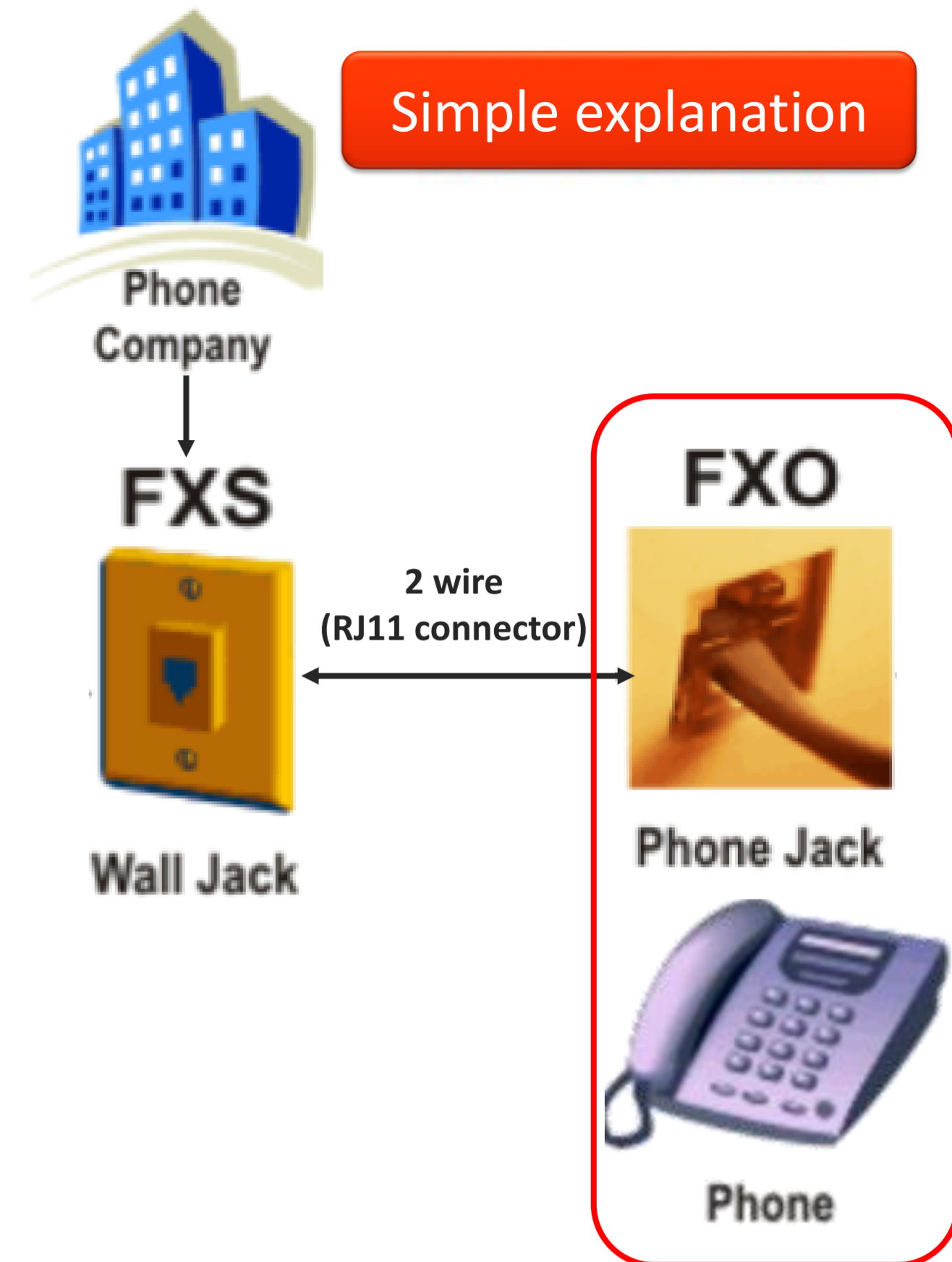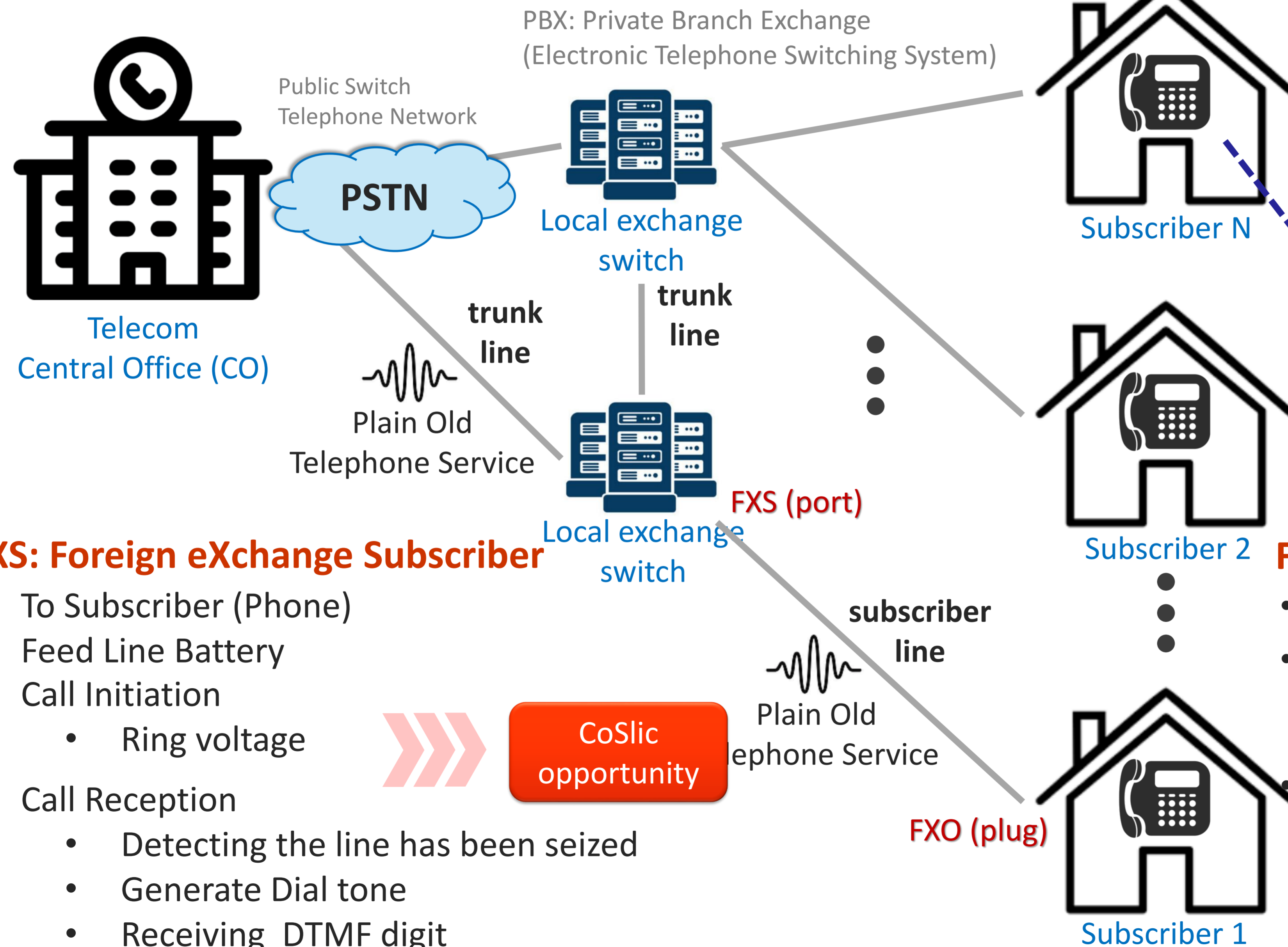
Telecom Network

PBX: Private Branch Exchange
(Electronic Telephone Switching System)

Public Switch
Telephone Network

PSTN

Local exchange
switch

Subscriber N

Phone
Company

FXS

Wall Jack

FXO

Phone Jack

2 wire
(RJ11 connector)

Phone

trunk line

trunk line

Telecom
Central Office (CO)

Plain Old
Telephone Service

Local exchange
switch

FXS (port)

Subscriber 2

subscriber line

Plain Old
Telephone Service

FXO (plug)

Subscriber 1

FXS: Foreign eXchange Subscriber

- To Subscriber (Phone)
- Feed Line Battery
- Call Initiation
    - Ring voltage
- Call Reception
    - Detecting the line has been seized
    - Generate Dial tone
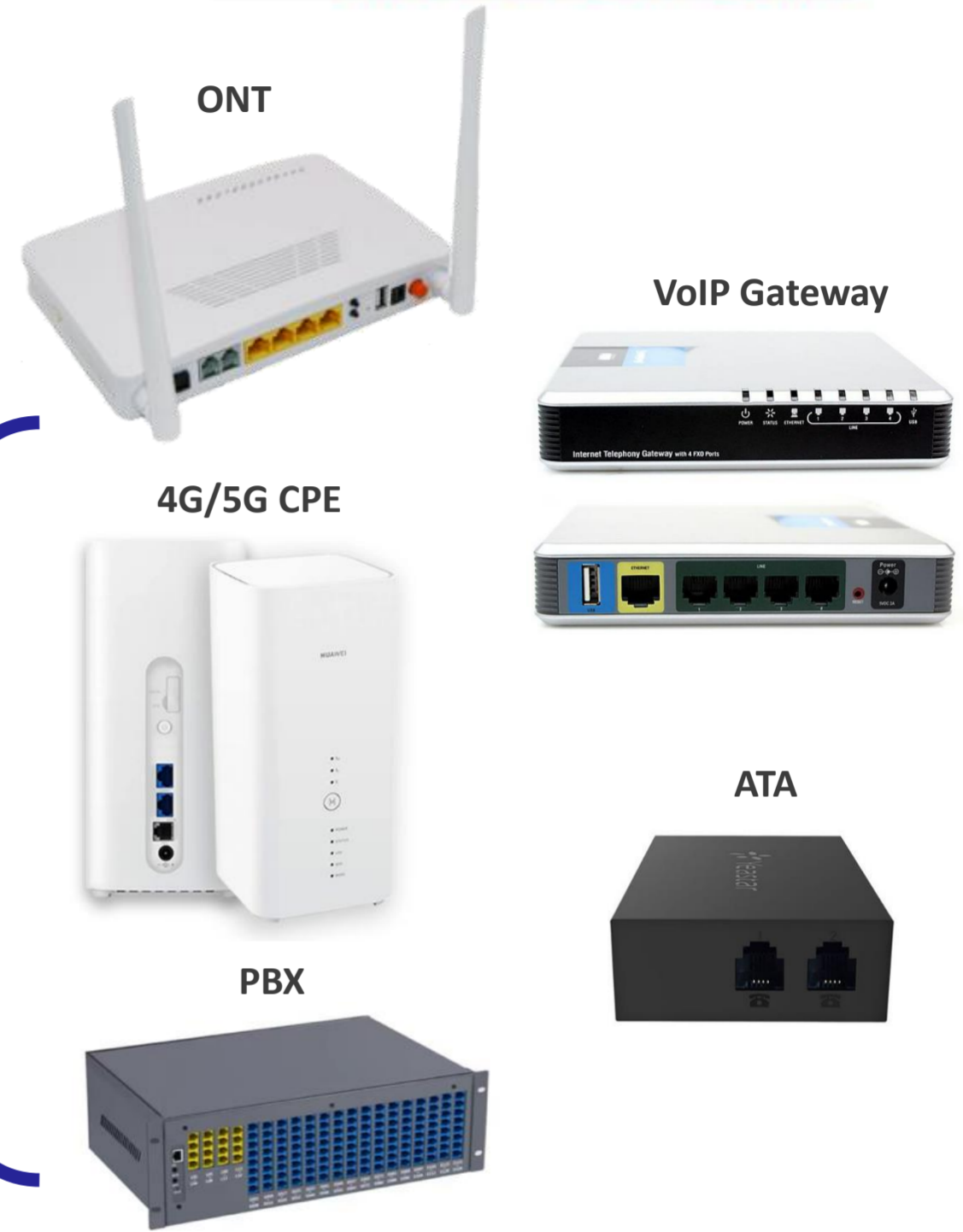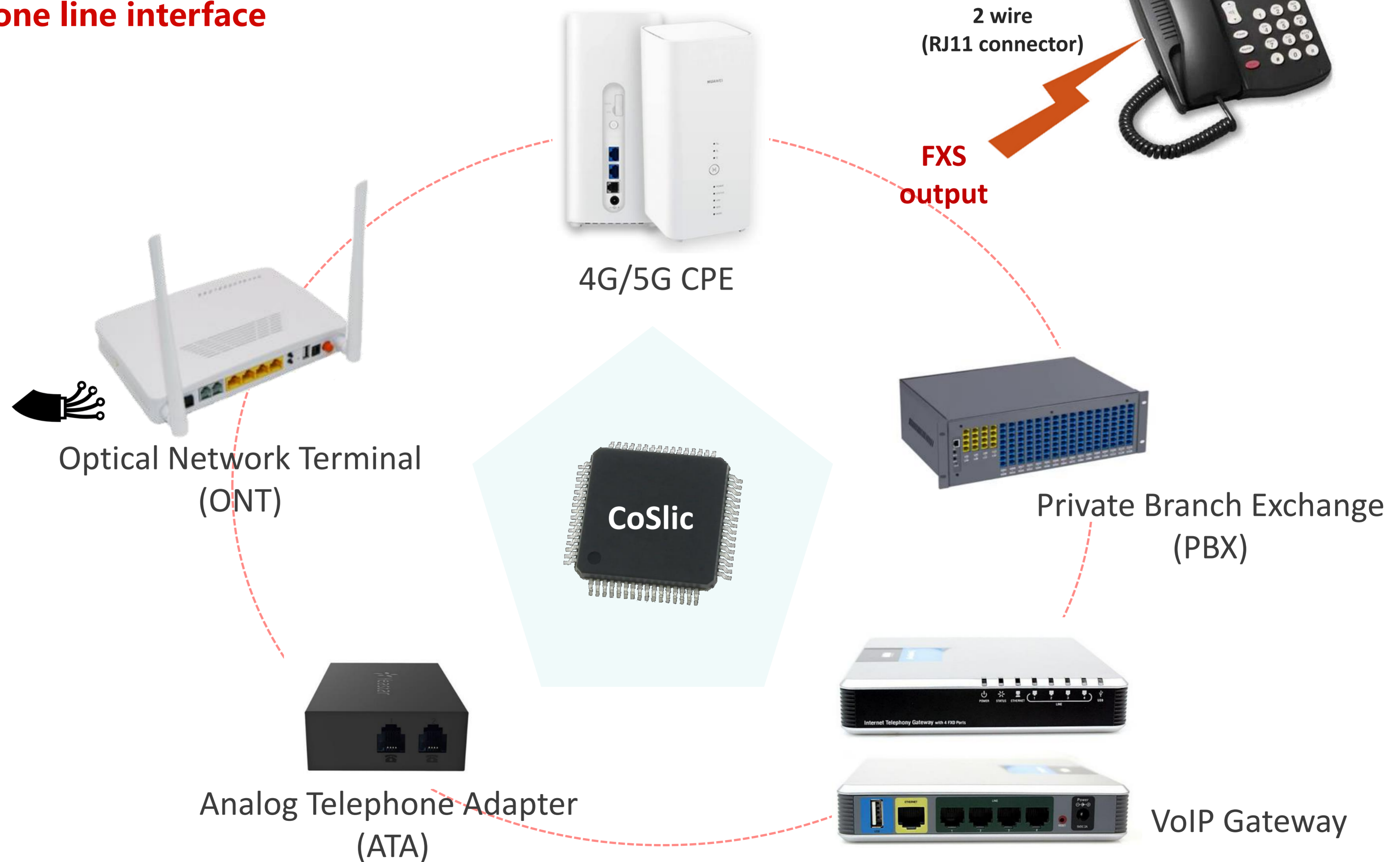   - Receiving DTMF digit

FXO: Foreign eXchange Office

- To Local exchange switch
- Call Reception
    - Detecting the ring voltage
    - Off-Hook to answer the call
- Call Initiation
    - Off-Hook to seize the line
    - Hearing Dial tone
    - Dialing DTMF digit

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Telecom Network

PBX: Private Branch Exchange
(Electronic Telephone Switching System)

Public Switch
Telephone Network

PSTN

Local exchange
switch

trunk line

trunk line

Subscriber N

Telecom
Central Office (CO)

Plain Old
Telephone Service

Local exchange
switch

FXS (port)

ONT

VoIP Gateway

4G/5G CPE

ATA

PBX

FXS: Foreign eXchange Subscriber

- To Subscriber (Phone)
- Feed Line Battery
- Call Initiation
  - Ring voltage

- Call Reception
  - Detecting the line has been seized
  - Generate Dial tone
  - Receiving DTMF digit

CoSlic
opportunity

subscriber line

Plain Old
Telephone Service

FXO (plug)

Subscriber 2

Subscriber 1

FXO: Foreign eXchange Office

- To Local exchange switch
- Call Reception
  - Detecting the ring voltage
  - Off-Hook to answer the call
- Call Initiation
  - Off-Hook to seize the line
  - Hearing Dial tone
  - Dialing DTMF digit

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Coslic Target Market

FXS telephone line interface

4G/5G CPE

2 wire
(RJ11 connector)

FXS output

Optical Network Terminal
(ONT)

CoSlic

Private Branch Exchange
(PBX)

Analog Telephone Adapter
(ATA)

VoIP Gateway

Joy of innovation
nuvoTon

Application: GPON (Gigabit-capable Passive Optical Network)

Joy of innovation
nuvoTon

GPON ONT Share Market

◆ GPON Market size surpassed USD 10 billion in 2021 and is poised to grow at over 10% CAGR from 2022 to 2028. Global GPON product shipments exceeded 250 million units in 2021.
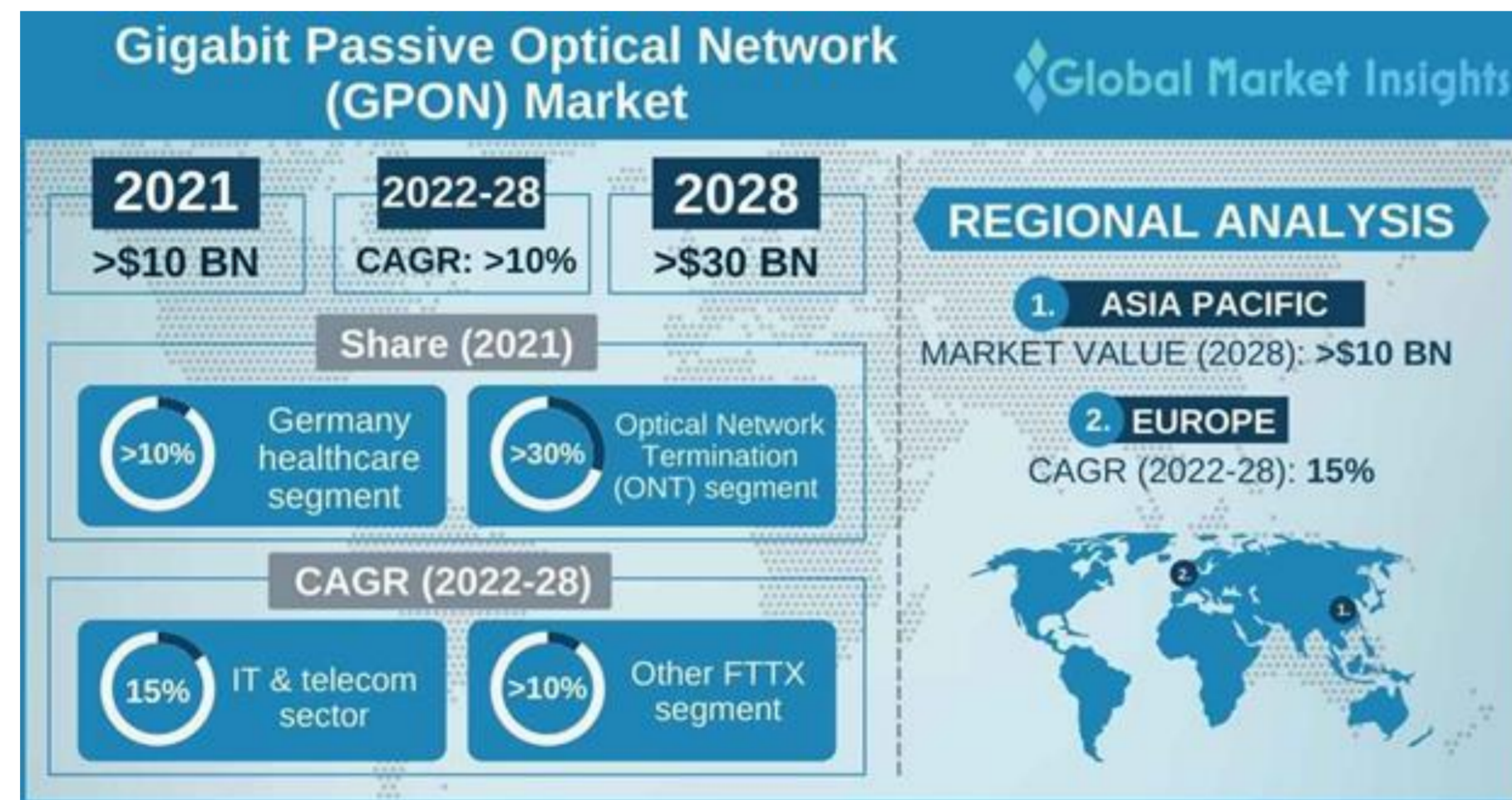
Source: Global Market Insights
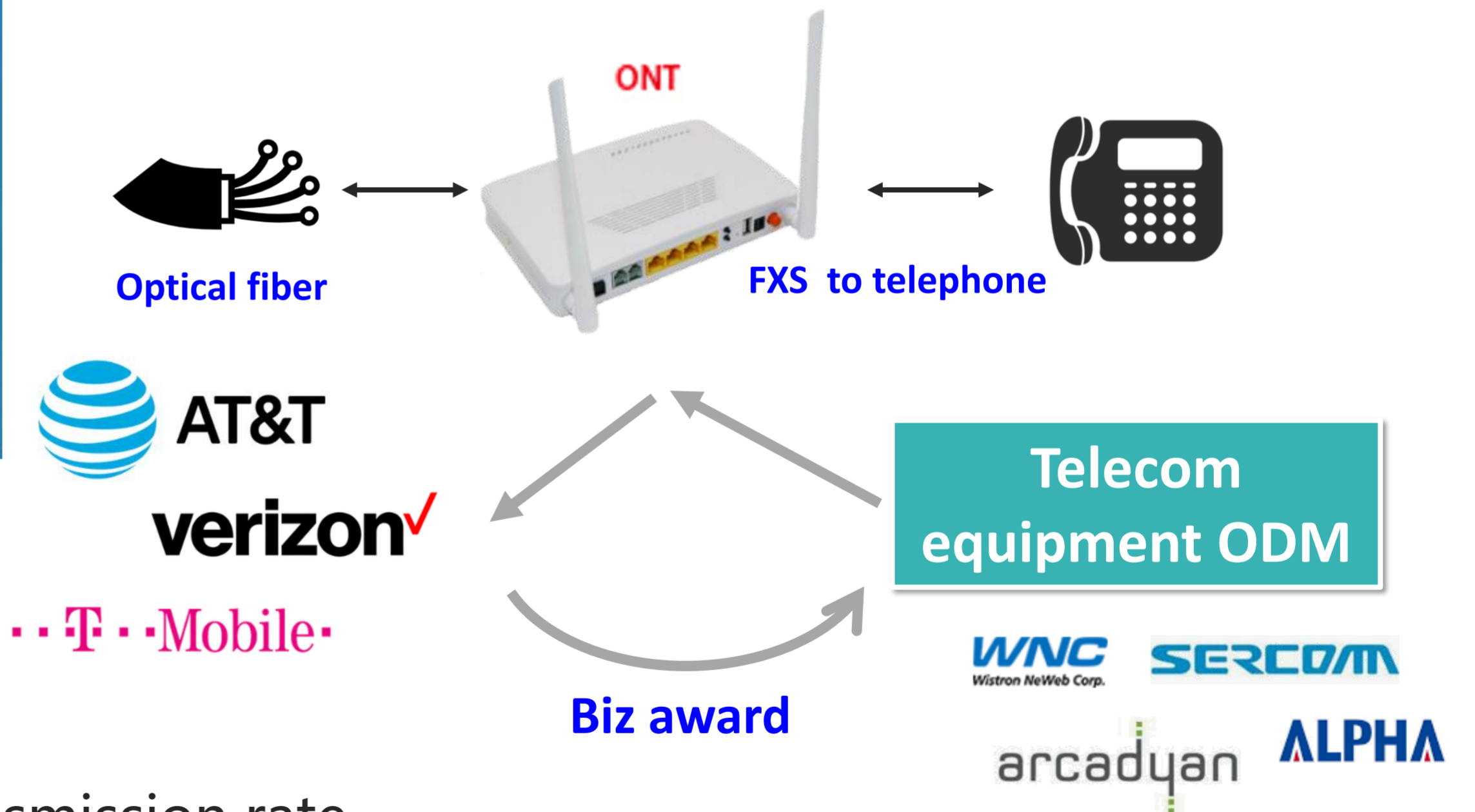
◆ Opportunity : telecom operators open bid

◆ Opportunity : new generation ONT have fast data transmission rate

Super fast internet speed

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Application: GPON

GPON: Gigabit-capable Passive Optical Network

Internet

CATV — Core — PSTN

Switch

OLT

Optical splitter

OLT

ONU

VoIP | Video conferencing | PC | Voice

Office network

ONU | ONU | AP

Cameras | Information exchange terminals | Mobile terminals

Public facility network

ONT

Voice | TV | PC
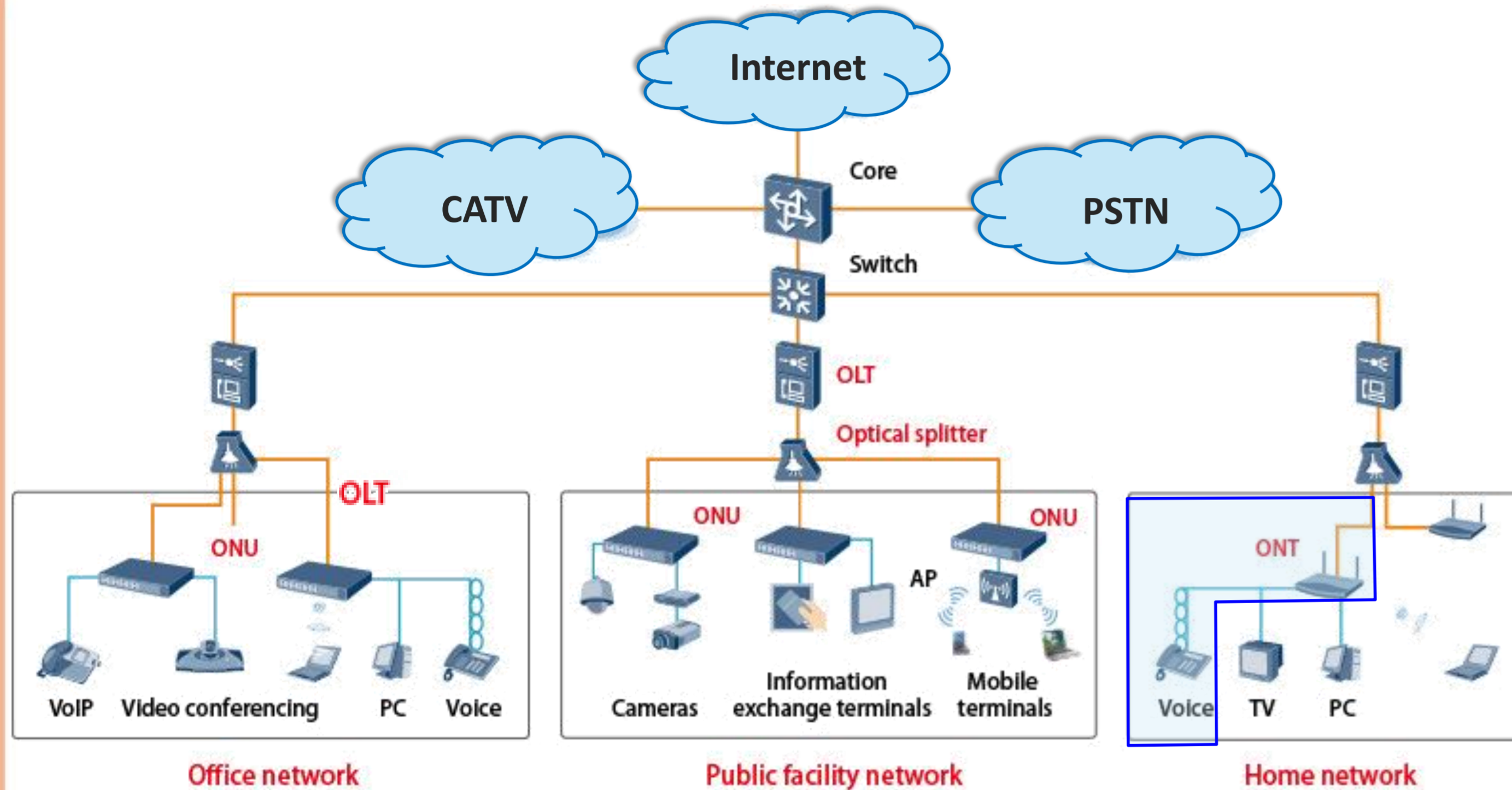
Home network

FTTB (Fiber To The Building)

FTTE (Fiber To The Exchange)

FTTH (Fiber To The Home)

- OLT(Optical Line Terminal)
- ONU(Optical Network Unit)
- ONT(Optical Network Terminal)
  → Fiber Optical Modem

ONT

FXS to telephone

Tip & Ring

RJ11 | RJ45

coslic | Magnetics module

SPI | PCM

GPON Phy — GPON SoC — Wifi

Electronic signal

Optical signal
Voice & Internet service

RAM | Flash

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Application: 4G / 5G CPE

CPE: Customer Premise Equipment

4G LTE CPE   5G CPE

Base Station
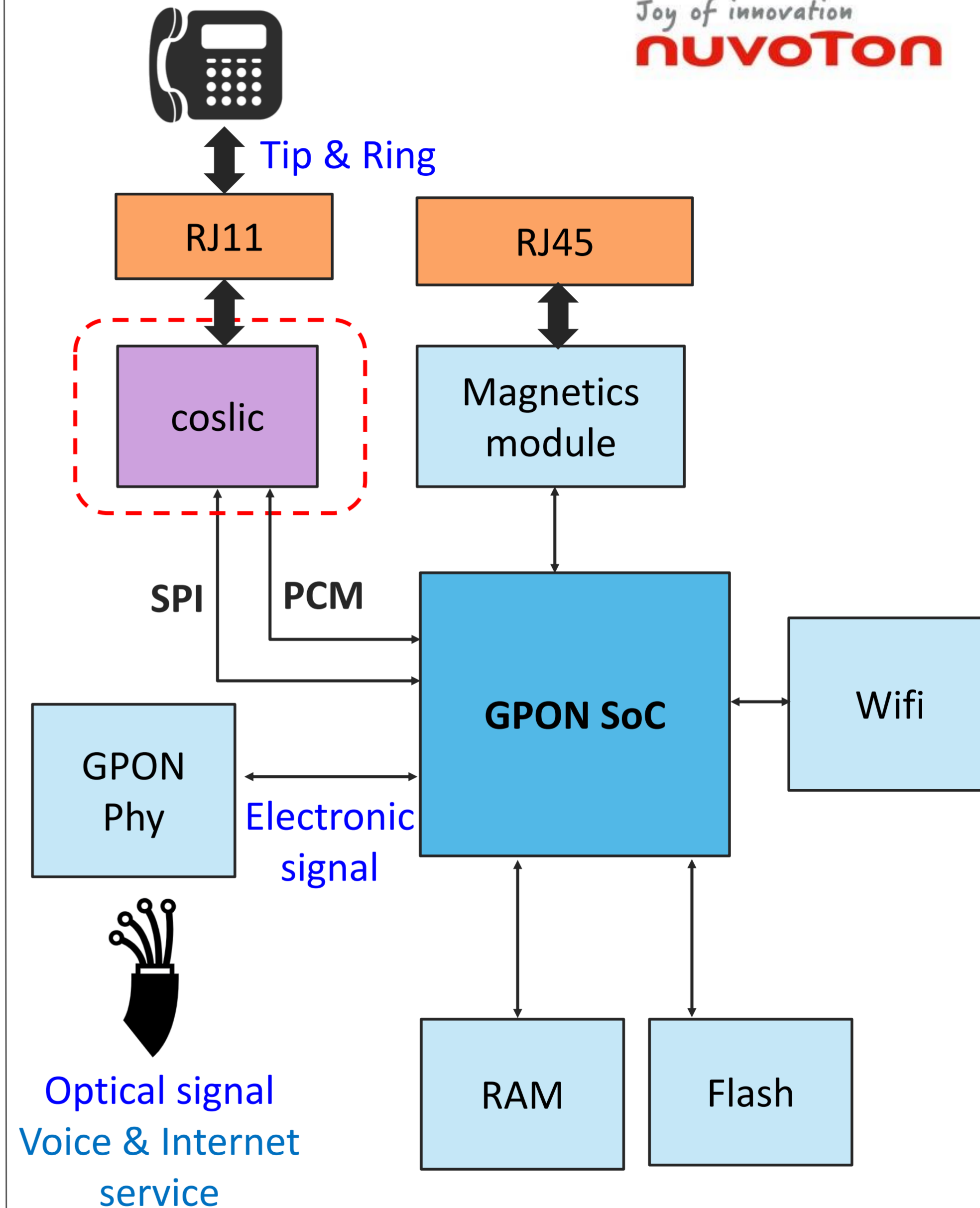
FXS port
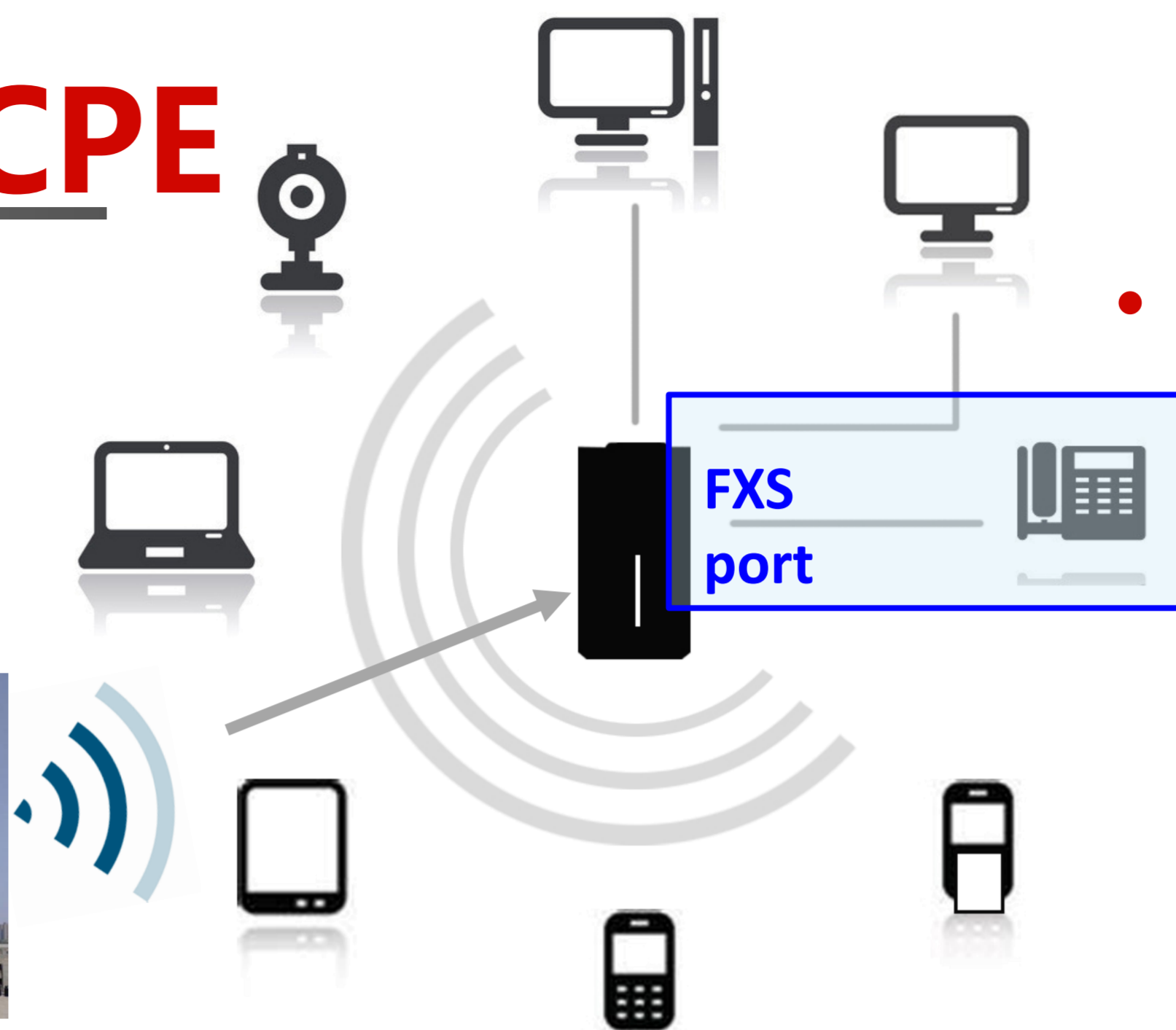
- CPE with slic interface
  - China: 0%
  - US-Euro: 40~50%
    - **TAM: 3KK**

- Shipment Volume of the Global 5G CPE (Customer Premises Equipment) industry is estimated to reach 9 million units in 2022
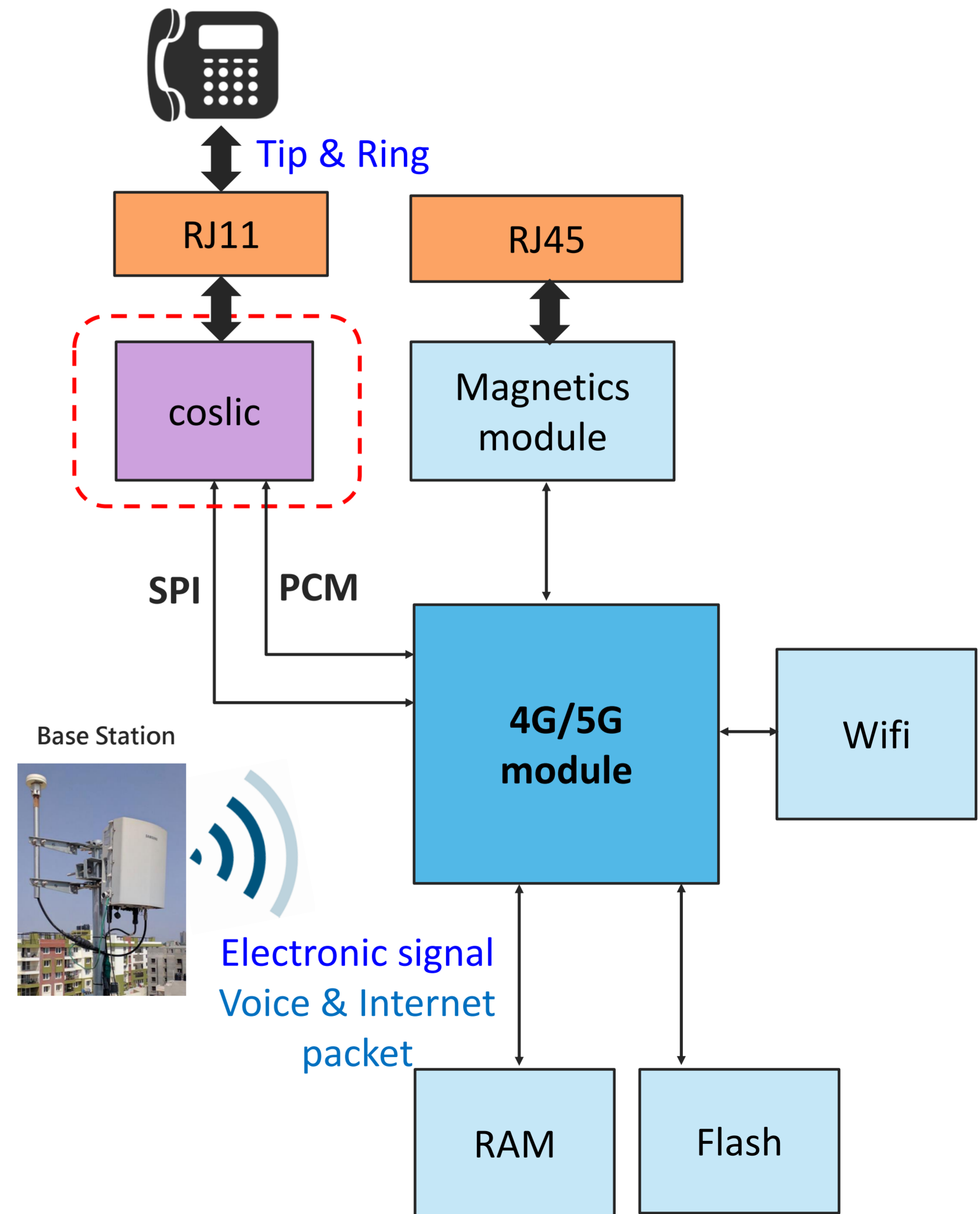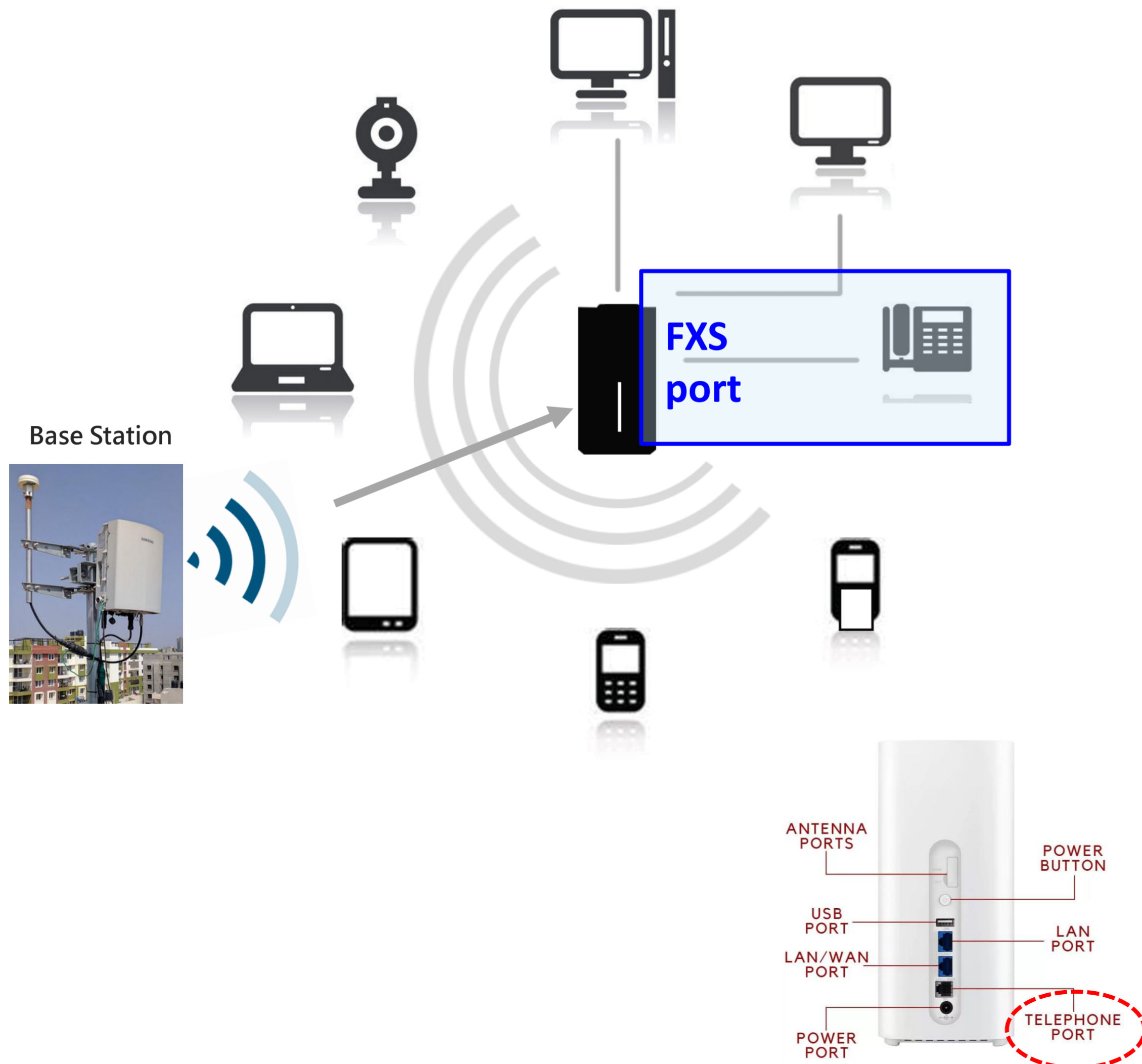

	2019	2020(e)	2021(f)	2022(f)	2023(f)	2024(f)
Mi-Fi	0.7	1.1	1.8	3.0	4.0	5.1
FWA	0.2	1.2	3.8	9.2	12.8	15.4
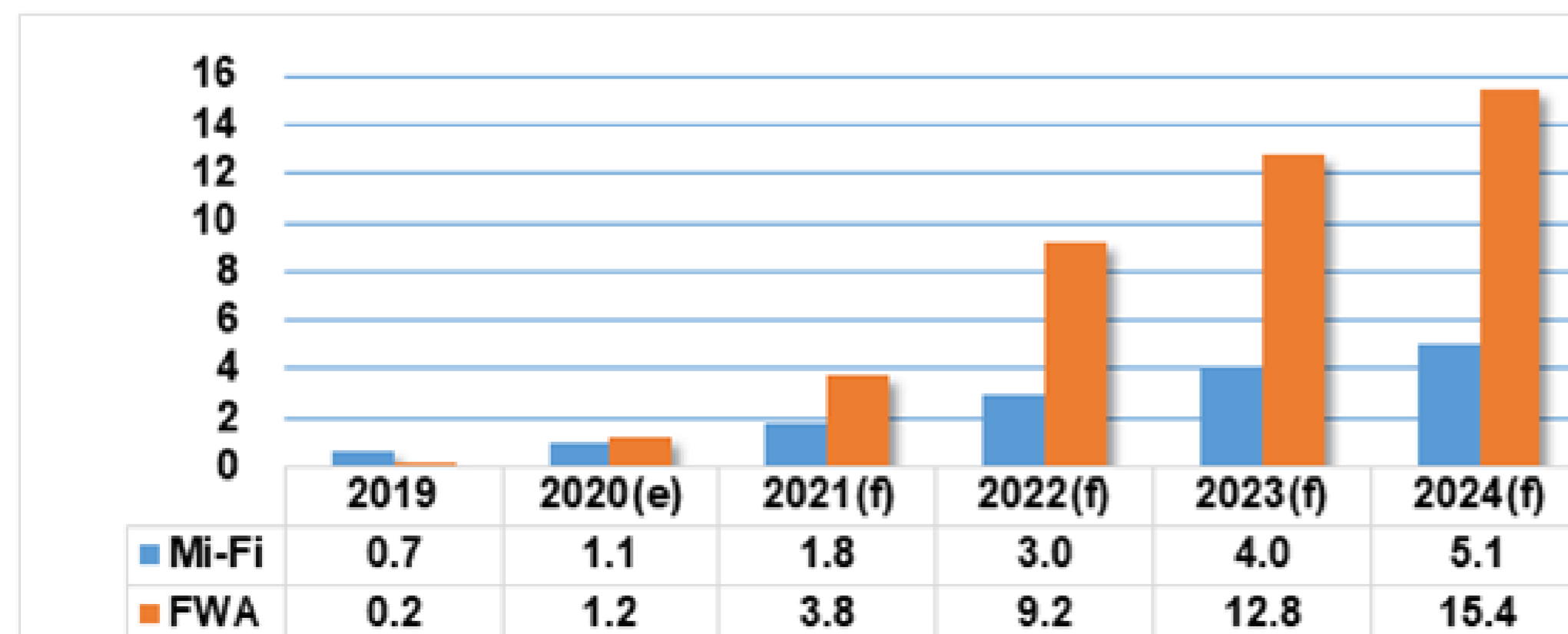
Note: Unit in milion;
Mi-Fi standards for Mobile Wi-Fi;
FWA standards for Fixed Wireless Access
Source: mic

Application: 4G / 5G CPE

CPE: Customer Premise Equipment

FXS port

Base Station

ANTENNA PORTS

POWER BUTTON

USB PORT

LAN PORT

LAN/WAN PORT

POWER PORT

TELEPHONE PORT

Tip & Ring

RJ11

RJ45

coslic

Magnetics module

SPI

PCM

Base Station

4G/5G module

Wifi

Electronic signal Voice & Internet packet

RAM

Flash

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Application: PBX

PBX: Private Branch Exchange

- PBX is a telephone system within an enterprise that switches calls between users on local lines, while enabling all users to share a certain number of external phone lines.

- Benefits:
    - Interactive Voice Response
    - cost savings on internal phone calls

- Application:
    - Office
    - Hotel
    - Hospital
    - School
    - Bank
    - more and more…

Telecommunications Cabinet

PBX Channel card inside

External call

PBX

internal call
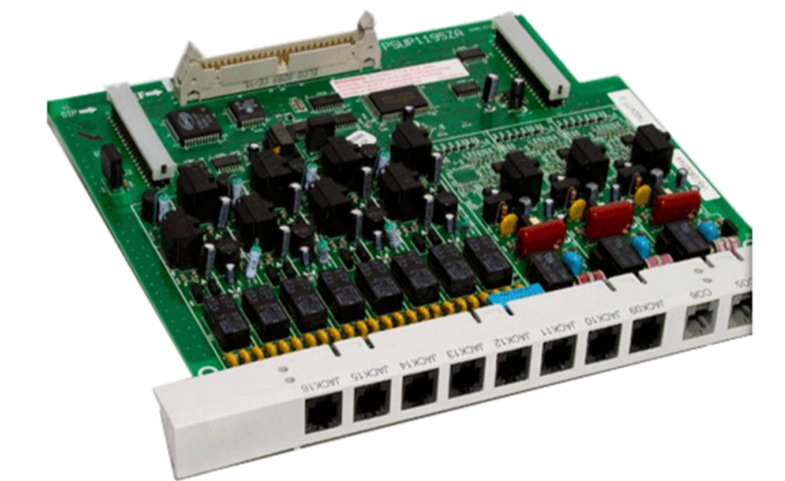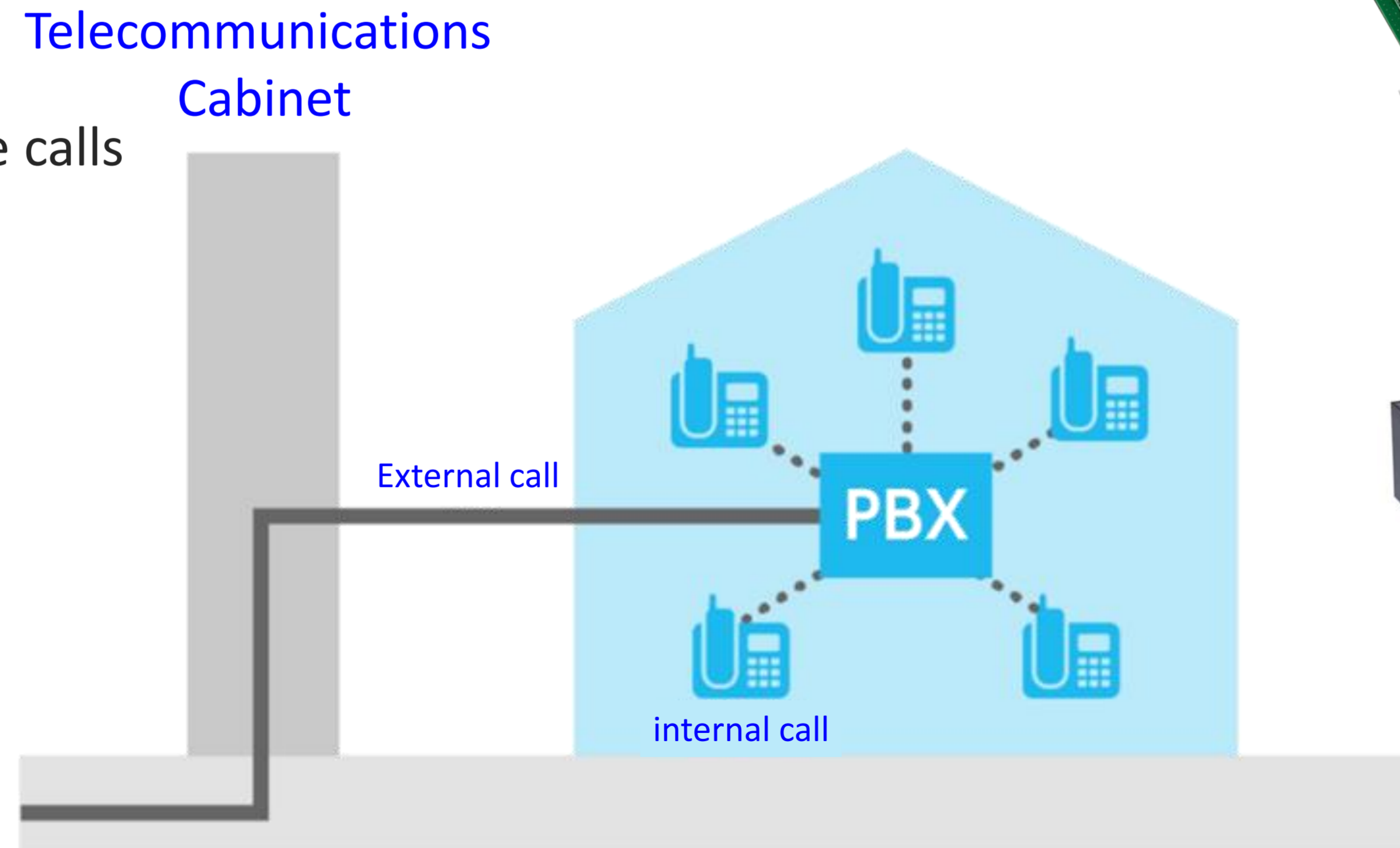
PBX

Application: VoIP Gateway

implements a single channel FXS telephone line interface
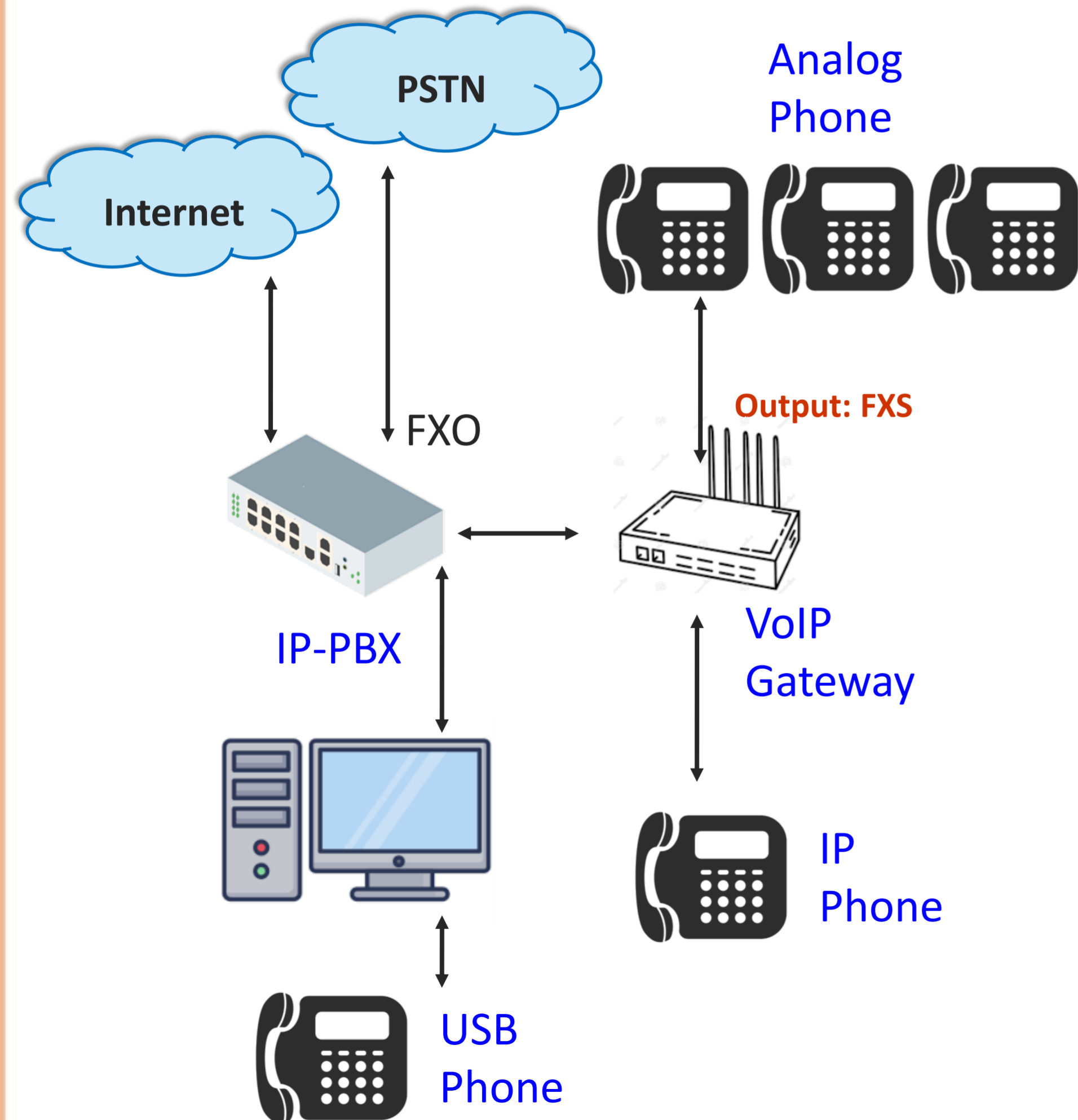
VoIP Network

FXS (Foreign eXchange Station)

- Connect to analog telephone

- Provide linefeed battery, linefeed current, ringing signal

- DTMF & Caller ID

- Voice CODEC

  – ADC: Tip/Ring translate to digital

  – DAC: digital covert to Tip/Ring

Application: Analog Telephone Adapter

implements a single channel FXS telephone line interface
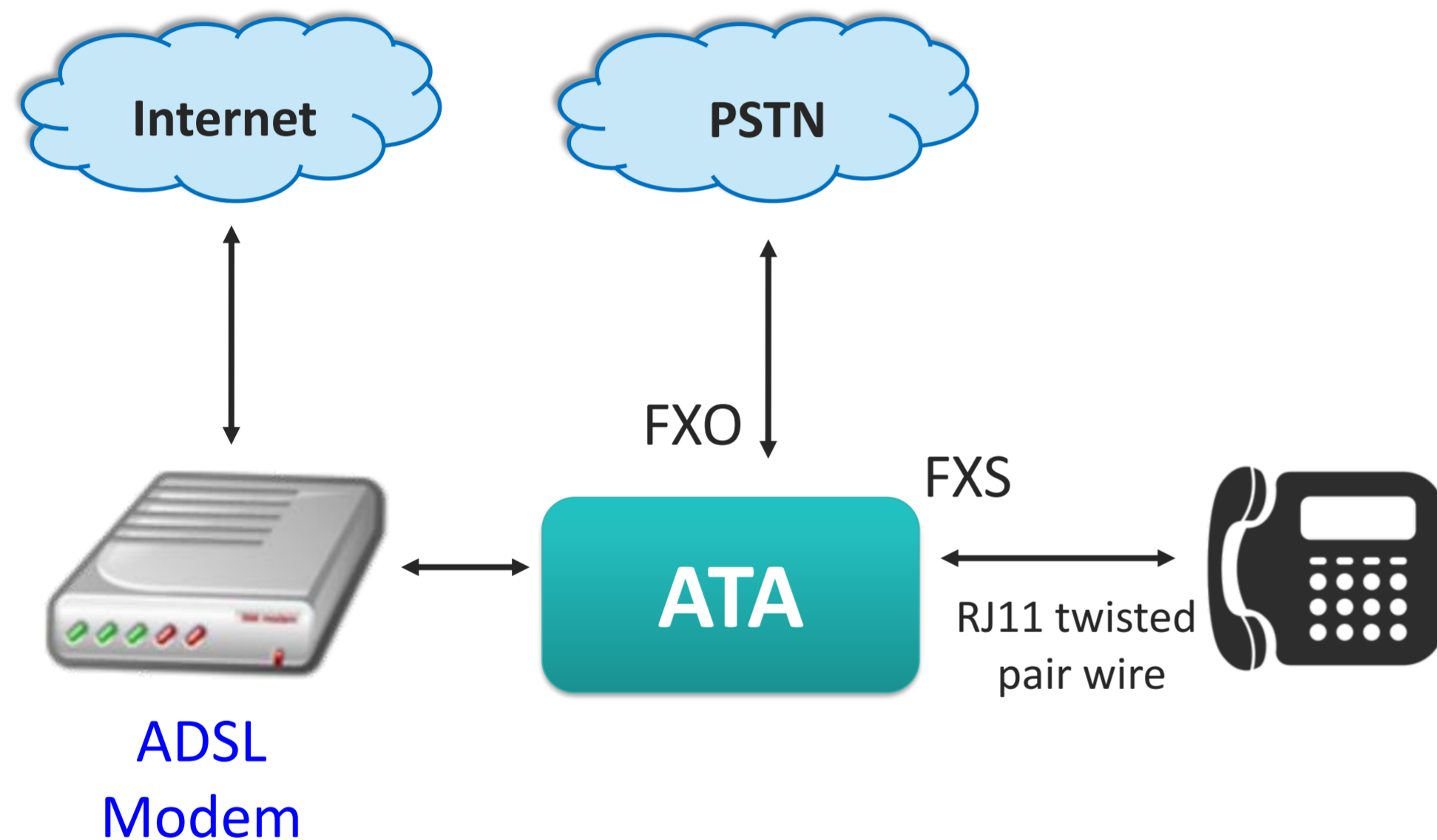
VoIP Network

Internet

PSTN

FXO

FXS

ATA

RJ11 twisted pair wire

ADSL Modem

Suitable

Output: FXS

- Personal

- SOHO (Small Office Home Office)

FXS (Foreign eXchange Station)

- Connect to analog telephone

- Provide linefeed battery, linefeed current, ringing signal

- DTMF & Caller ID

- Voice CODEC

  - ADC: Tip/Ring translate to digital

  - DAC: digital covert to Tip/Ring

FXS

CoSlic

VoIP SoC

Internet

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What is CoSlic

PBX: Private Branch Exchange
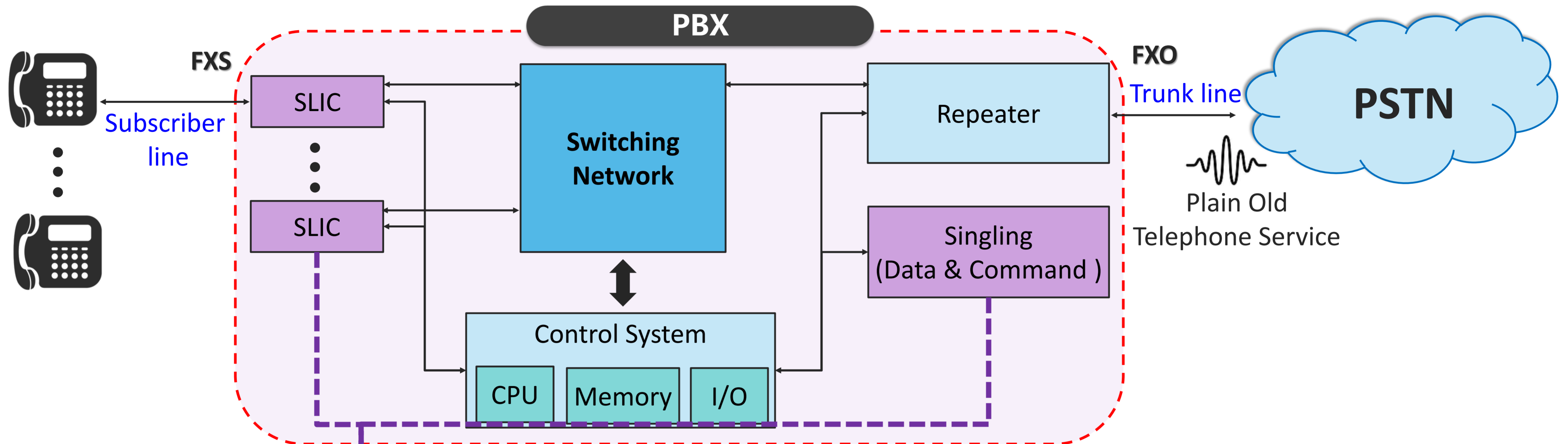
- SLIC (Subscriber Line Interface Circuit) – 2 wire (Tip & Ring)
  - On-Hook: Tip: Ground / Ring: Negative Voltage (ex: VDC: -40~-60V)
  - Upon Ring: high voltage (ex: VAC: 75~90V) & low frequency (ex: 20~50Hz) AC signal on DC voltage
  - Off-Hook: detect DTMF & generate dial tone & transmit voice AC signal
- Codec:
  - Voice A/D & D/A including μ-Law, A-Law , 16-bit linear PCM

* Depend on country regulation

Coslic
- Codec
- SLIC

N681389

The CoSlic is used to simulate the application of telephone FXS line interface.
It enables signals to be transmitted and received, power to be fed to the line and monitoring of the line condition.

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CoSlic product portfolio

# of FXS channel

- Complete BORSCHT functions
- Programmable linefeed characteristics
- Integrated DC/DC controller
- Wideband and Narrowband codec
- PCM/SPI interface

N682389
- Dual Channel FXS
- VBAT：-120V
- VBAT source: 3
- μ-Law, A-Law , 16-bit linear PCM
- Package: QFN-80
- Operation Temperature: -40～85℃

N681389
- Single Channel FXS
- VBAT：-100V
- VBAT source: 1
- μ-Law, A-Law, 16-bit linear PCM
- Package: QFN-44
- Operation Temperature: -40 ~ 85℃

2022

2023.Q2

Production Development

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N681389 CoSlic

implements a single channel FXS telephone line interface

Complete BORSCHT functions

- **Battery Feed**
  - Integrated DC/DC controller regulates battery
  - Programmable external battery switching
- **Over-Voltage Protection**
  - DCDC output voltage (VBAT) Over-Voltage Alarm
  - DCDC supply current too high
  - Monitor the internal power dissipation
  - On-chip temperature sensor senses the temperature inside the package
- **Ringing**
  - Balanced & Unbalanced Ring
  - Sinusoidal or trapezoidal waveforms
  - Programmable Ringing Frequency, Amplitude, and Cadence

- **Supervision**
  - Loop Closure Detection
  - Ground Key Detection & Ground Fault Detection
  - TIP Over Current & Ring Over Current Detect
  - Caller ID (type1 & 2) by FSK Generation
  - DTMF Generator & DTMF Detection
- **Coding**
  - A-law & µ-law & 16bit Linear PCM
- **Hybrid**
  - Two wire AC impedance, and trans-hybrid balance
- **Testing and Diagnostics**
  - Loop Back Tests
  - RC Measurement (RCM) Mode
  - With 352-bytes Diagnostic FIFO, used for GR-909 line test

N681389 CoSlic

implements a single channel FXS telephone line interface

Key Features

- \# of FXS channel: 1
- Max $V_{Battery}$: -104V
- Loop current: 5mA~45mA
- Tone Generator: 3sets
- Wideband and Narrowband codec
- ESD: 2KV
- Control by SPI Bus
- Voice data via PCM Slave mode
- I/O operating voltage: 1.8 & 3.3V
- Operation Temperature: -40 ~ 85℃
- On-chip PLL: 1.024MHz, 2.048MHz, 4.096MHz, 8.192MHz
- Package: QFN-44

Block Diagram
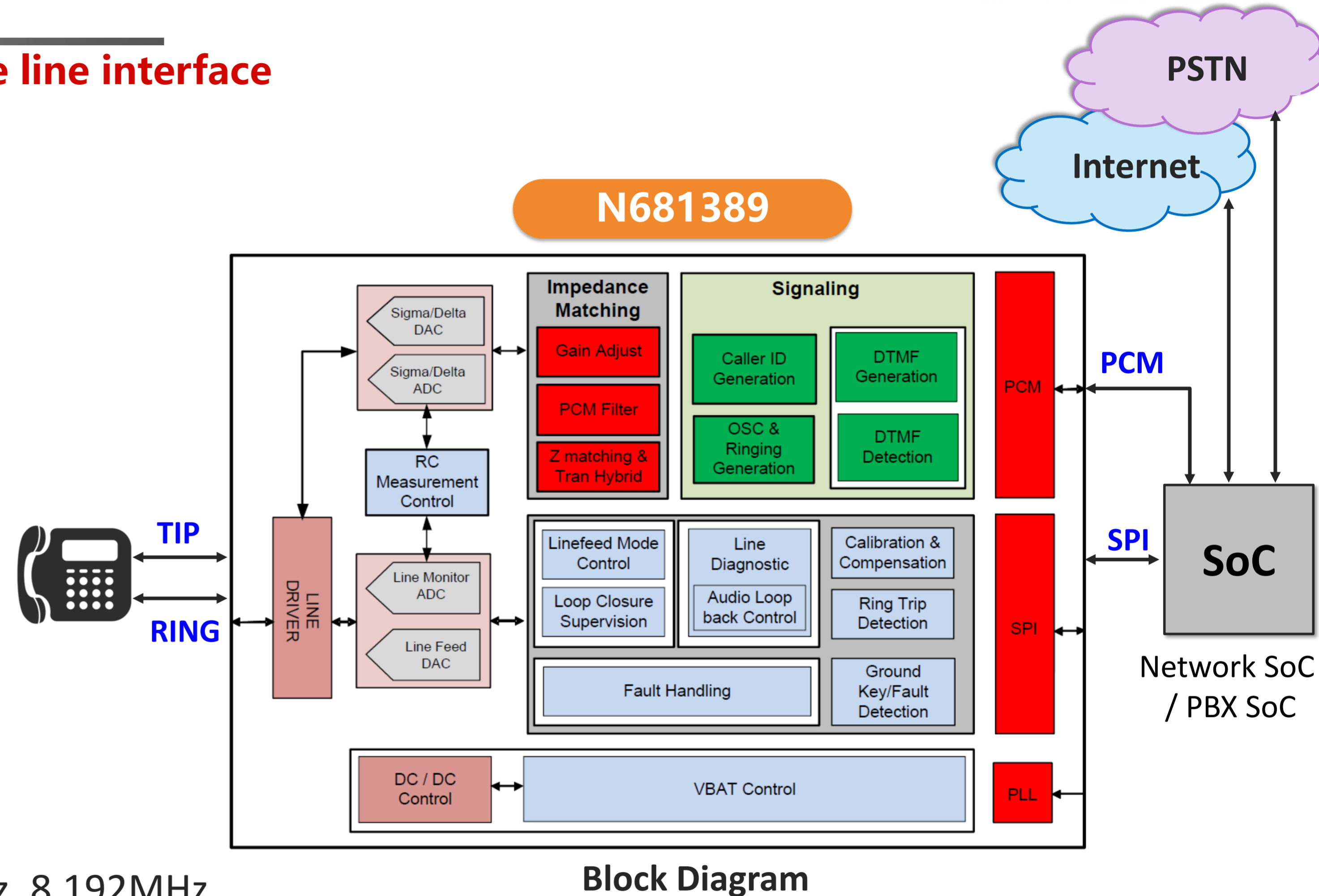
N681389 – Key Promotion Point

implements a single channel FXS telephone line interface

- **Reduce Design Barrier**

  - No PLL

  - An on-chip PWM driver allows control of an inductor based DC/DC converter.

- **Worldwide deployment**

  - Programmable impedance and trans-hybrid balancing allow for worldwide deployment.

- **Enhanced audio quality**

  - Standard Narrowband (FS: 8K) codec

  - Enhanced Wideband (FS: 16K) codec

- **EVB/GUI for fast Evaluation/Development**

  - Easy to use, Full Feature

Country	Requirement Impedance Element (Unit)		
	R1(Ohm)	R2(Ohm)	C(Farad)
US PBX, Korea, Taiwan	600	0	Null
Standard	900	0	Null
CTR21	270	750	150n
China CO	200	680	100n
China PBX	200	560	100n
Germany (Legacy)	220	820	115n
India, New Zealand	370	620	310n
Unknown	0	800	50n

N681389 Hardware Development Tools

Product Launch

- **Sample**
  - Schedule: Available Now!
- **Datasheet**
  - Schedule: Available Now!
- **MotherBoard+N681389-EVB**
  - Purpose: Verify CoSlic with **nuvoTon GUI** by USB
  - Ordering P/N: NE-N681389
  - Available Now!

Joy of innovation
nuvoTon

USB

MotherBoard

N681389-EVB

TIP
RING

Customer system

N681389-EVB

SoC

SPI

PCM

Network SoC / PBX SoC

TIP
RING
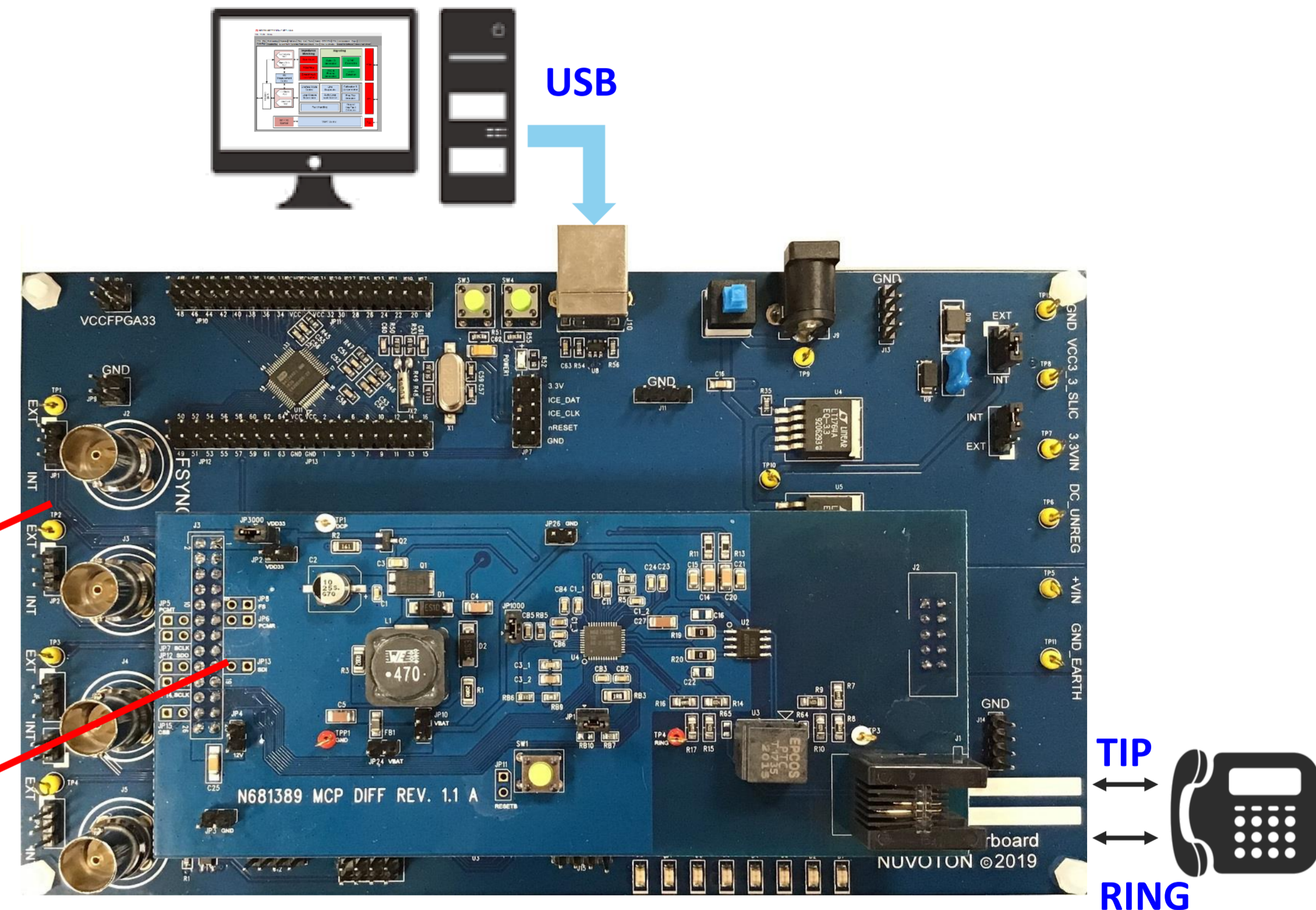
Customer can take N681389-EVB to verify CoSlic with owned **SoC** Platform by SPI if all understand CoSlic function

N681389 Software Development Tools

- ## nuvoTon CoSlic GUI

  - 2022/Q4 Ready

  - It is capable for mother board + N681389 EVB combination
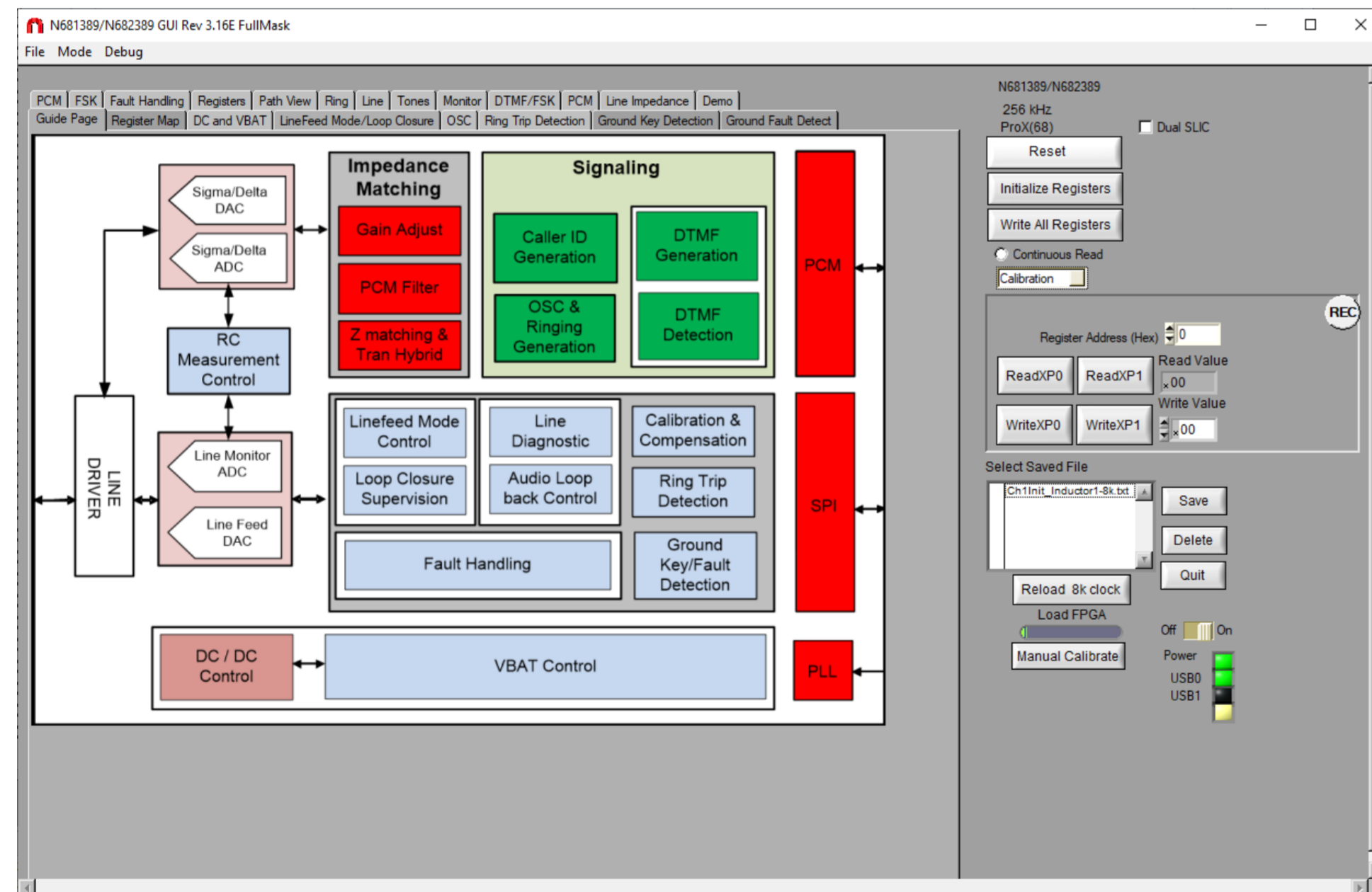
MotherBoard

N681389-EVB
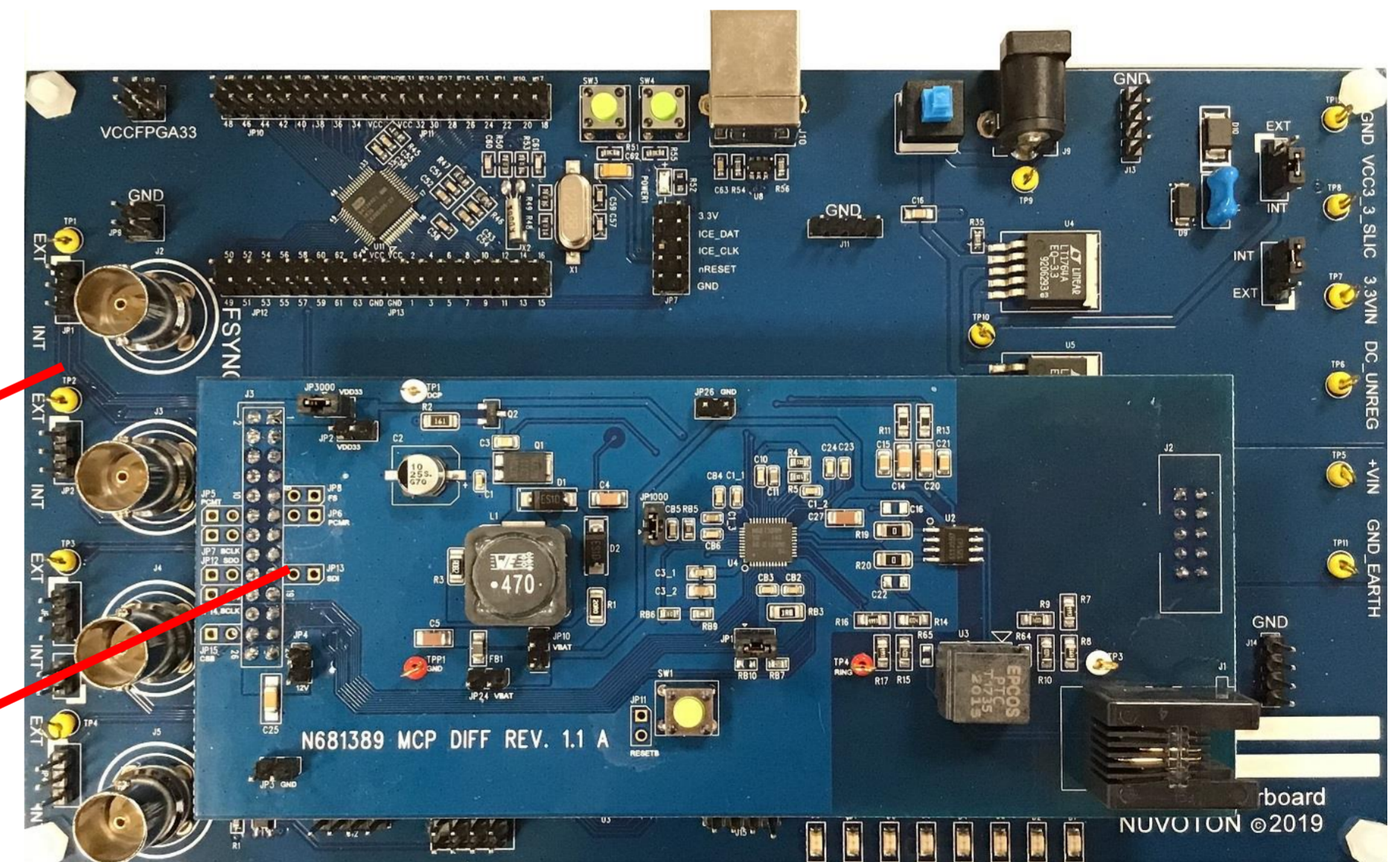
N681389 Software Development Tools

Release Development GUI

- ## nuvoTon SDK (C Reference Library)

  - Schedule: Available Now!

function	description	SDK func
Chip reset	1.Pull down GPIO then up to reset chip. 1.1.Repeat most 20 times or until the register access is valid. 2.Make chip software reset.	coslic_reset
Initail setting	Program the basic setting after the system first boots.	coslic_init

PCM format	To configure the format and data length of PCM.
	1.format: a-Law, u-Law, and linear
	2.Data length: 8, 16 bits.
		coslic_set_pcm_fmt
		@mode: transmit timeslot start bit of narrowband
		  COSLIC_PCM_ALAW: 8 bits a-Law
		  COSLIC_PCM_ULAW: 8 bits u-Law
		  COSLIC_PCM_LINEAR: 16 bits linear
		@data_len: receive timeslot start bit of narrowband
		  COSLIC_PCM_DL_8: 8 bit sample

PCM slot	configure TX/RX timeslot start bit	coslic_set_pcm_slot @tx_bit: transmit timeslot start bit of narrowband. @rx_bit: receive timeslot start bit of narrowband. @tx_bit_w: transmit timeslot start bit of wideband. @rx_bit_w: receive timeslot start bit of wideband.
PCM hardware parameters	To configure the sampling rate of PCM to 8 or 16 kHz.	coslic_set_hw_params @band: choose narrowband or wideband

Function Description

coslic-utils.c	C File
coslic-utils.h	H File
n68x_io.h	H File
n68x_spi.c	C File
n68x_spi.h	H File
n68x389-imz.c	C File
n681389.c	C File
n681389.h	H File
n681389.txt	Text Document

Sample Code

BRtg_BRrg_driver_sequence.pdf	
C1500_driver_sequence.pdf	
C13500_driver_sequence.pdf	
MRtg_MRrg_driver_sequence.pdf	
Rtr_Ctr_driver_sequence.pdf	
spi-bus.txt	
SRtg_SRrg_driver_sequence.pdf	
SRtr_driver_sequence.pdf	

Reference Documents