国家电网
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南瑞集团公司(国网电力科学研究院)
NARI GROUP CORPORATION / STATE GRID ELECTRIC POWER RESEARCH INSTITUTE

Laboratory investigation on graphic presentation for relay function sequence

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Outline

Motivation

Laboratory practices

Analysis

Motivation

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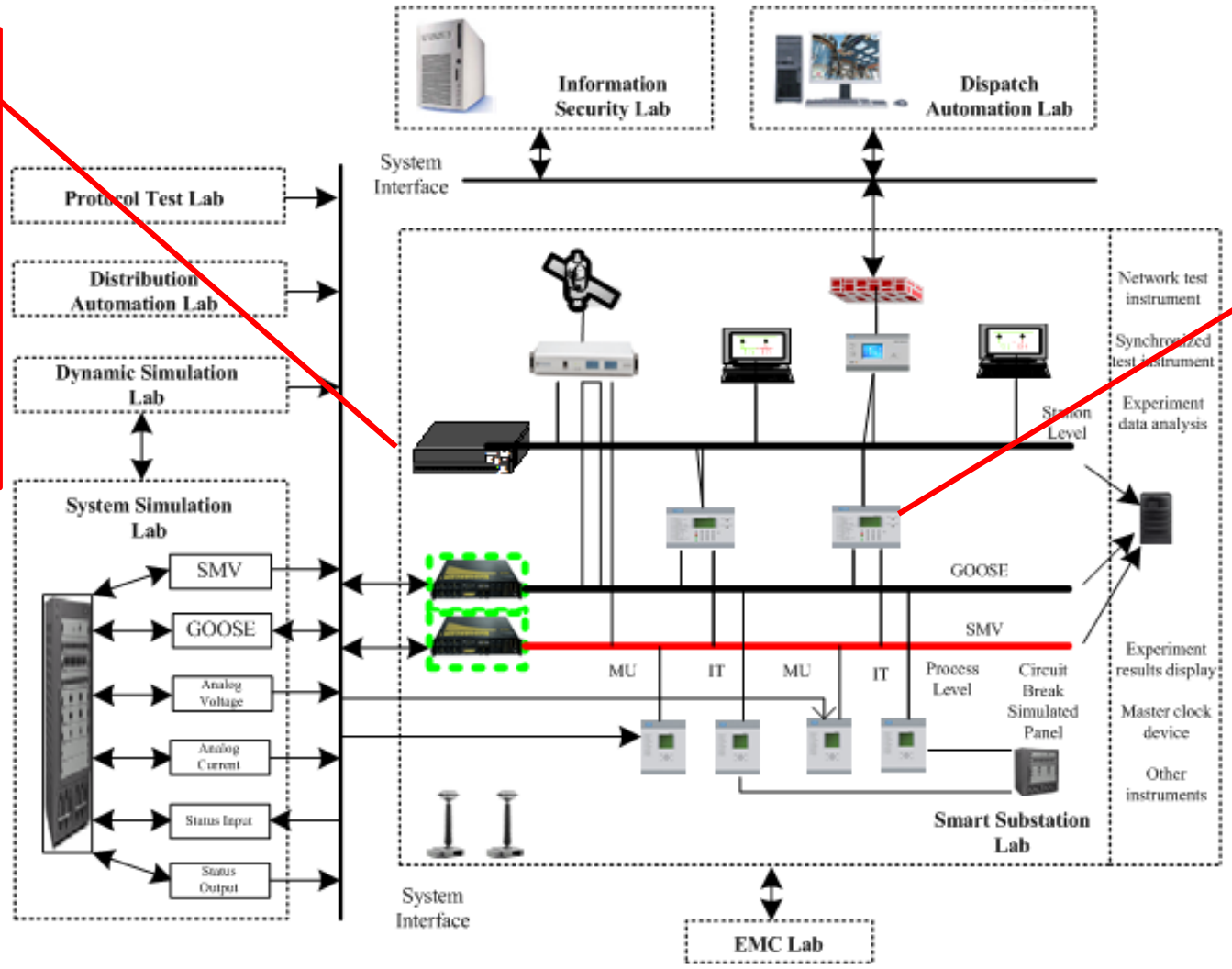
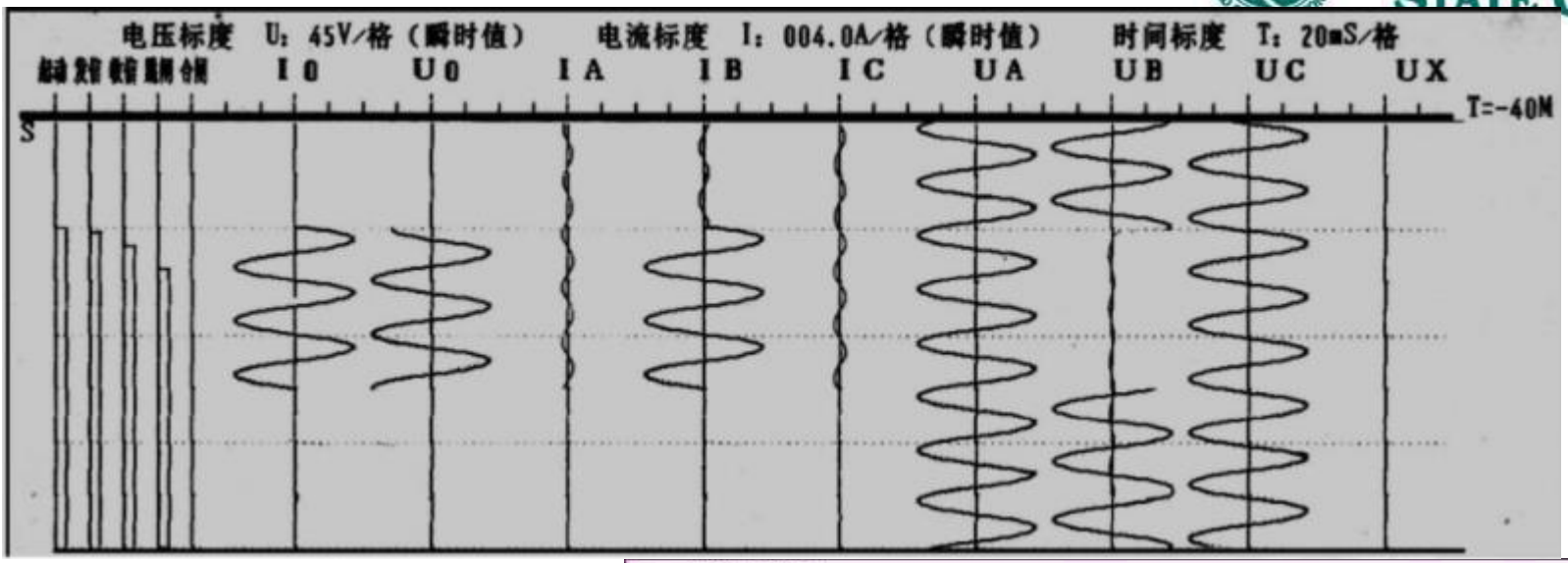
Motivation

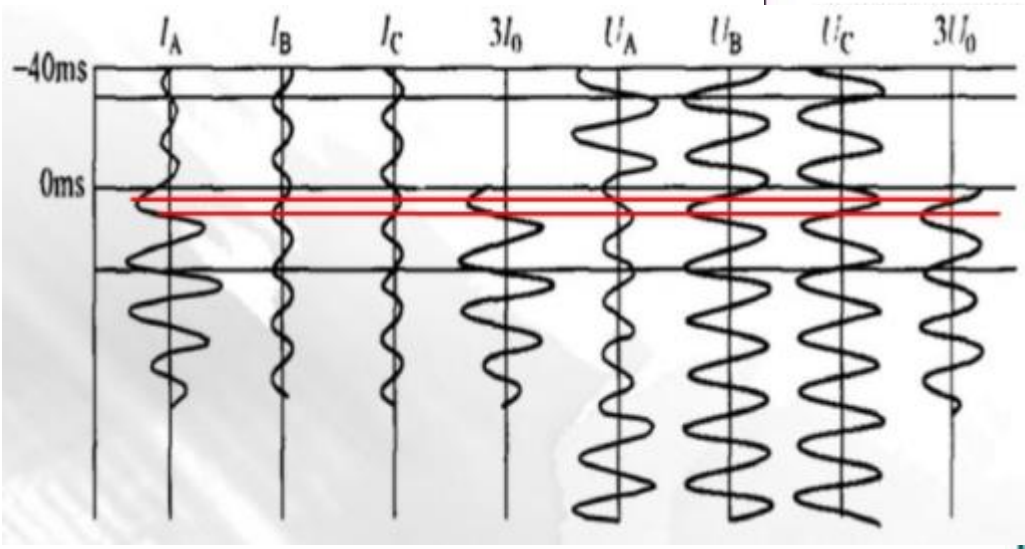
Substation automation system or sub-system, such as Protection and control system

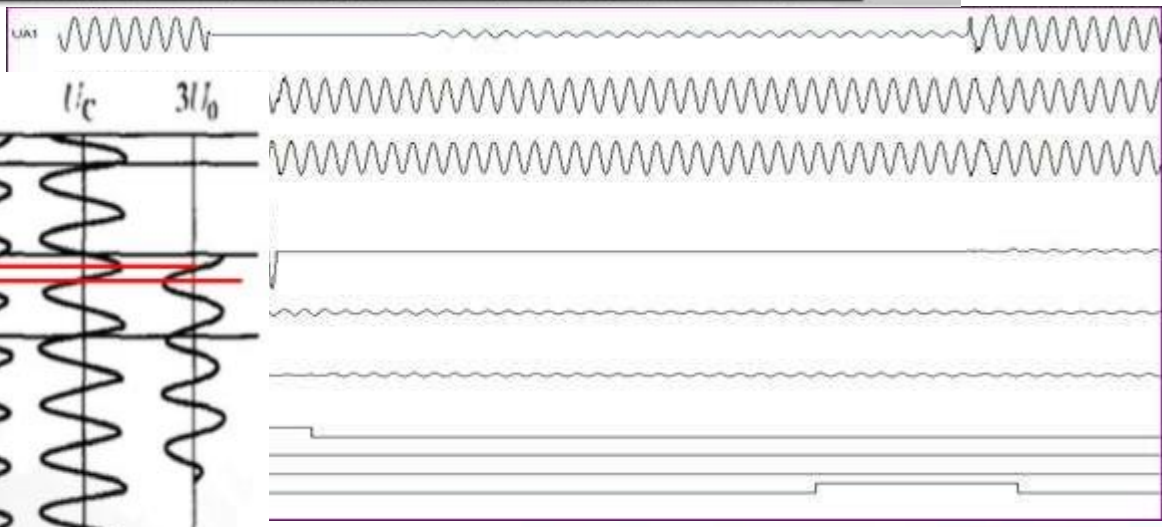


Individual IED is to be tested, maybe changed and instead by new one.

Motivation

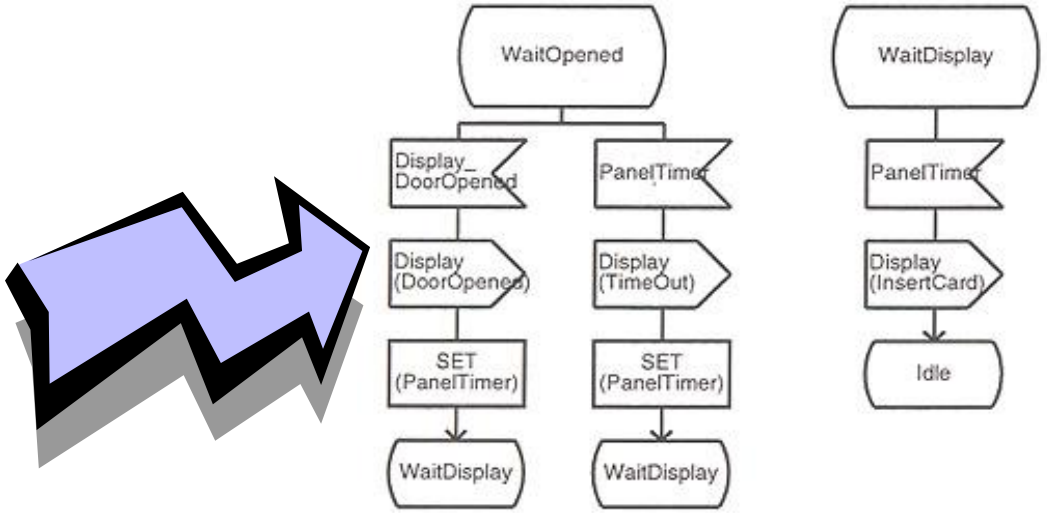






Graphic is Code

```
typedef basic_istream<_E, _Tr> _Myis;
ios_base::iostate _St = ios_base::goodbit;
bool _Chg = false;
_X.erase();
const _Myis::sentry _Ok(_I);
if (_Ok)
   (const _Ctype& _Fac = _USE(_I.getloc(), _Ctype);
   _TRY_IO_BEGIN
   _A::size_type _N = 0 < _I.width()
      && _I.width() < _X.max_size()
         ? _I.width() : _X.max_size();
   _Tr::int_type _C = _I.rdbuf()->sgetc();
   for (; 0 < --_N; _C = _I.rdbuf()->snextc())
      if(_Tr::eq_int_type(_Tr::eof(), _C))
         (_St |= ios_base::eofbit;
         break; )
      else if (_Fac.is(_Ctype::space,
         _Tr::to_char_type(_C)))
         break;
      else
         (_X.append(1, _Tr::to_char_type(_C));
         _Chg = true; )
   _CATCH_IO_(_I); )
_I.width(0);
if (!_Chg)
   _St |= ios_base::failbit;
  if (_Ok)
   (const _Ctype& _Fac = _USE(_I.getloc(), _Ctype);
   _TRY_IO_BEGIN
   _A::size_type _N = 0 < _I.width()
      && _I.width() < _X.max_size()
         ? _I.width() : _X.max_size();
   _Tr::int_type _C = _I.rdbuf()->sgetc();
   for (; 0 < --_N; _C = _I.rdbuf()->snextc())
      if(_Tr::eq_int_type(_Tr::eof(), _C))
         (_St |= ios_base::eofbit;
         break; )
      else if (_Fac.is(_Ctype::space,
         Tr::to_char_type( C)))
```



Code-Centered

Model-Centered

Ideas for SDL marries relay function

- ☑ Application of IEC 61850 provides standardization for relay function, which is the basis for adopting Specification Description Language
- ☑ Relay function standardized can be looked as State Machine
- ☑ Signals exchanging between relay function component can be looked as transition between state within State Machine System
- ☑ MSC graphic is suitable for presenting exchange sequence between relay function component

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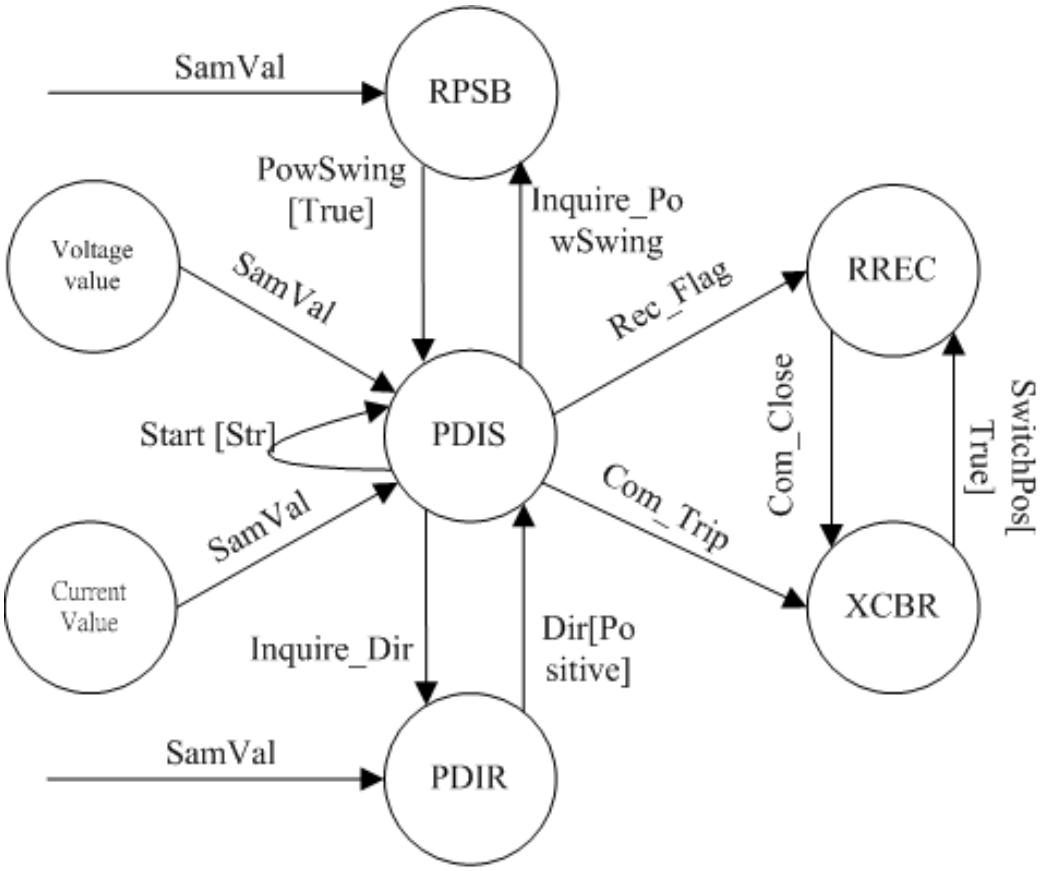
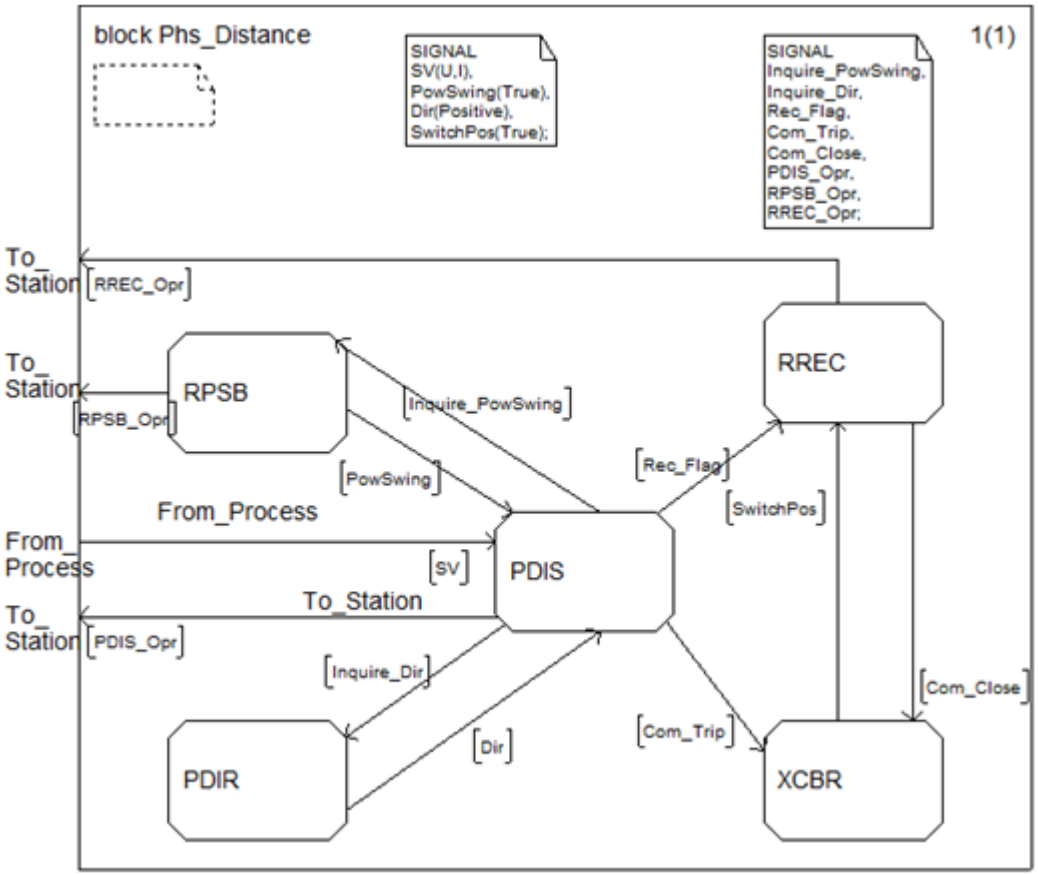
State machine



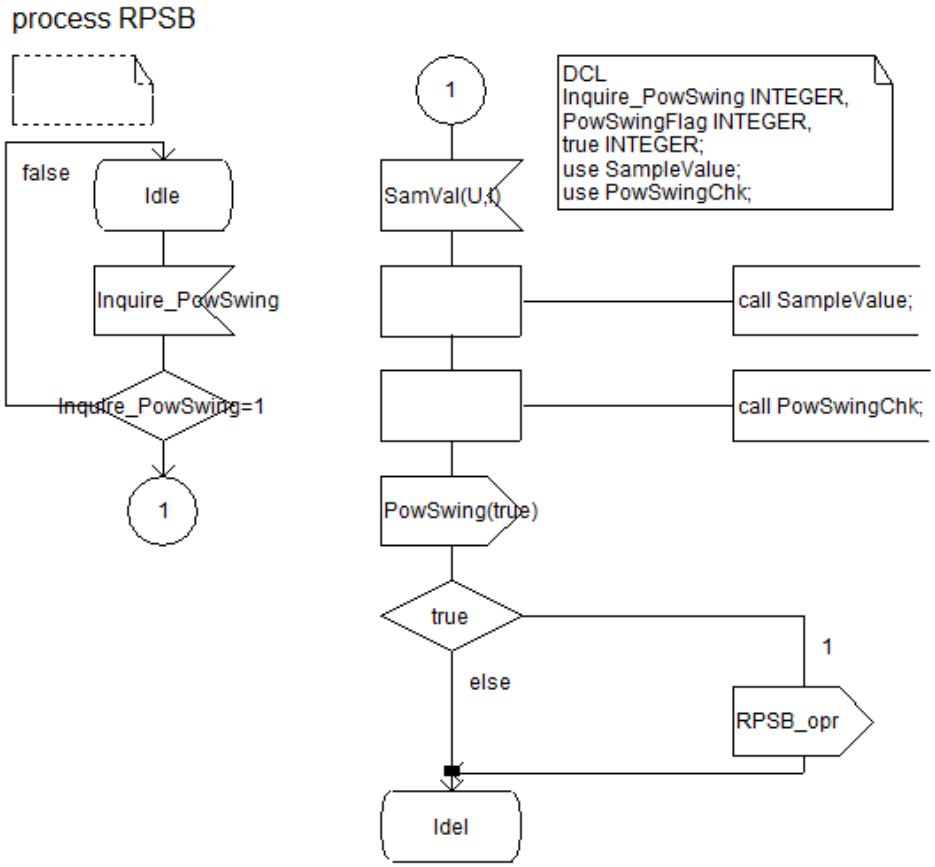
- ☑ The meaning of PDIS, RPSB, PDIR, RREC and XCBR reference to 61850 and the function model are also constructed belongs to IEC 61850
- ☑ The signal, such as SamVal, PowSwing[True], Start[Str], etc. are designed according to specification about data structure under SDL

SDL block system



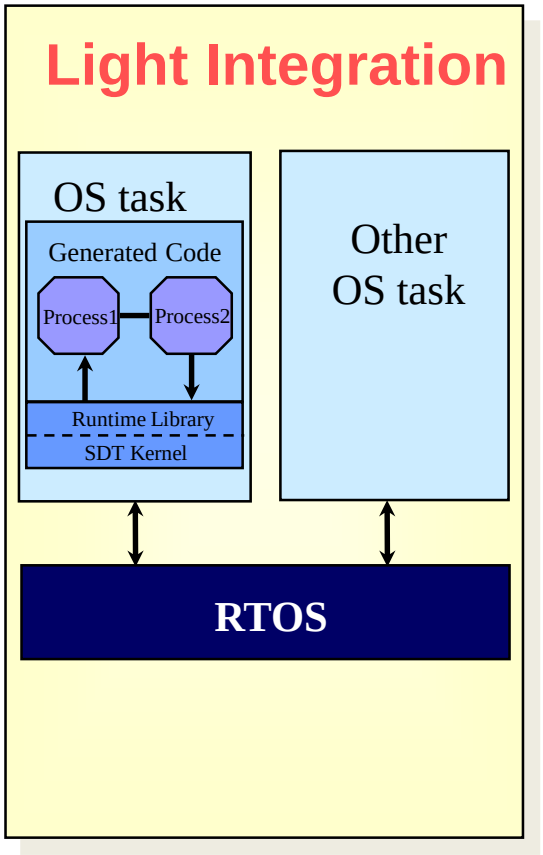
- ☑ Two parts are to be considered, one is exchange with outside environment, the another is exchange within system
- ☑ Embedded C program is used which can achieve relay function, and also the same program is re-used in SDL system, ensuring consistence with real relay device

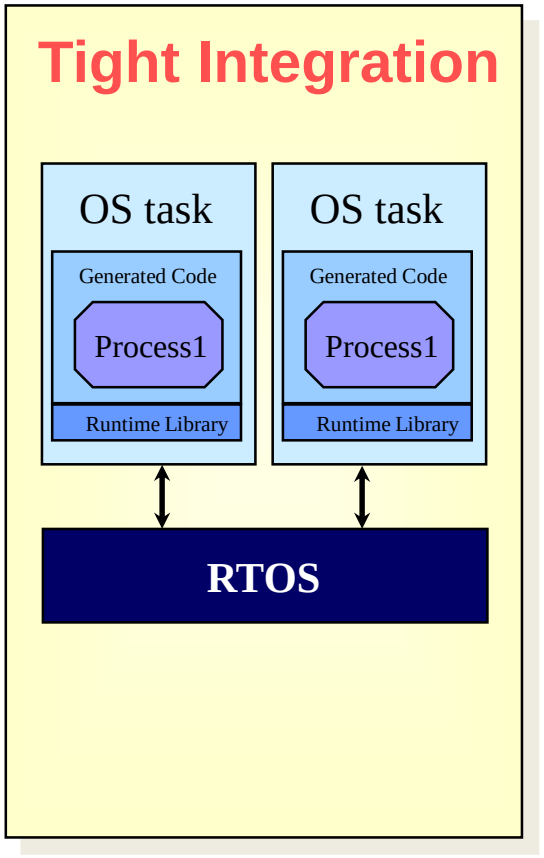
Process system



- ☑ Process is the basic component in SDL system and also the behavior of SDL
- ☑ In the case, process is the entity or body of responding relay function
- ☑ DCL is the declaration for calling and using data and function in external C program

System integration

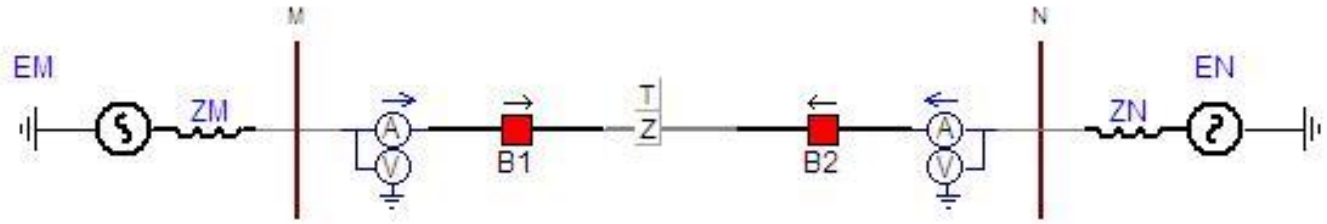




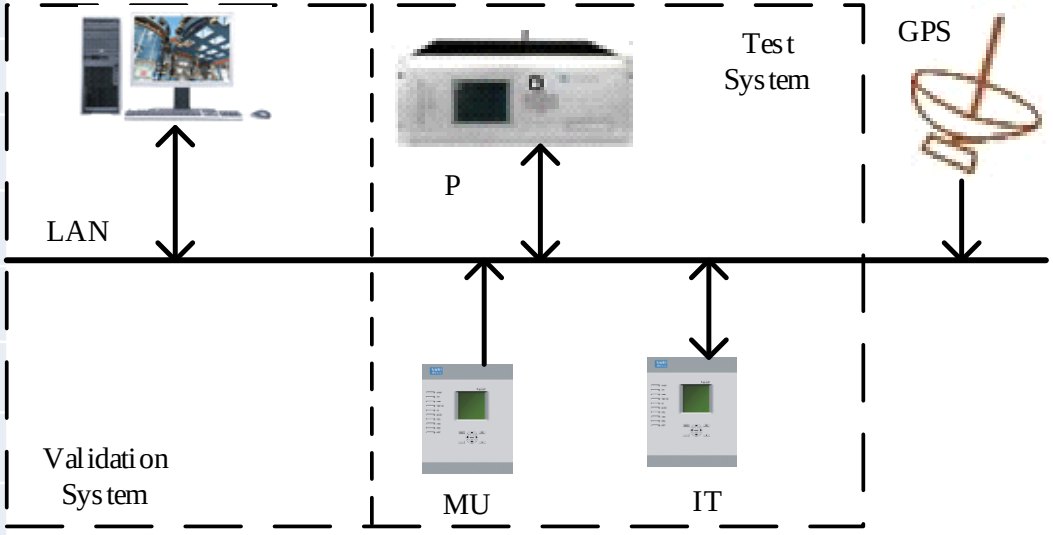
System integration

```
void main ( void )
{
/* initializing all sequences used with SDL system */
xmk_InitQueue ( void );
/* initializing the kernel of SDL system*/
xmk_InitSDL (void);
/*start SDL system*/
        void xmk_RunSDL (void);
        /*shutdown the communication interface with main
machine */
        void xmk_MicroTesterDeinit( void );
        /*initializing communication interface */
        void xmk_MicroTesterInit( void );
}
```

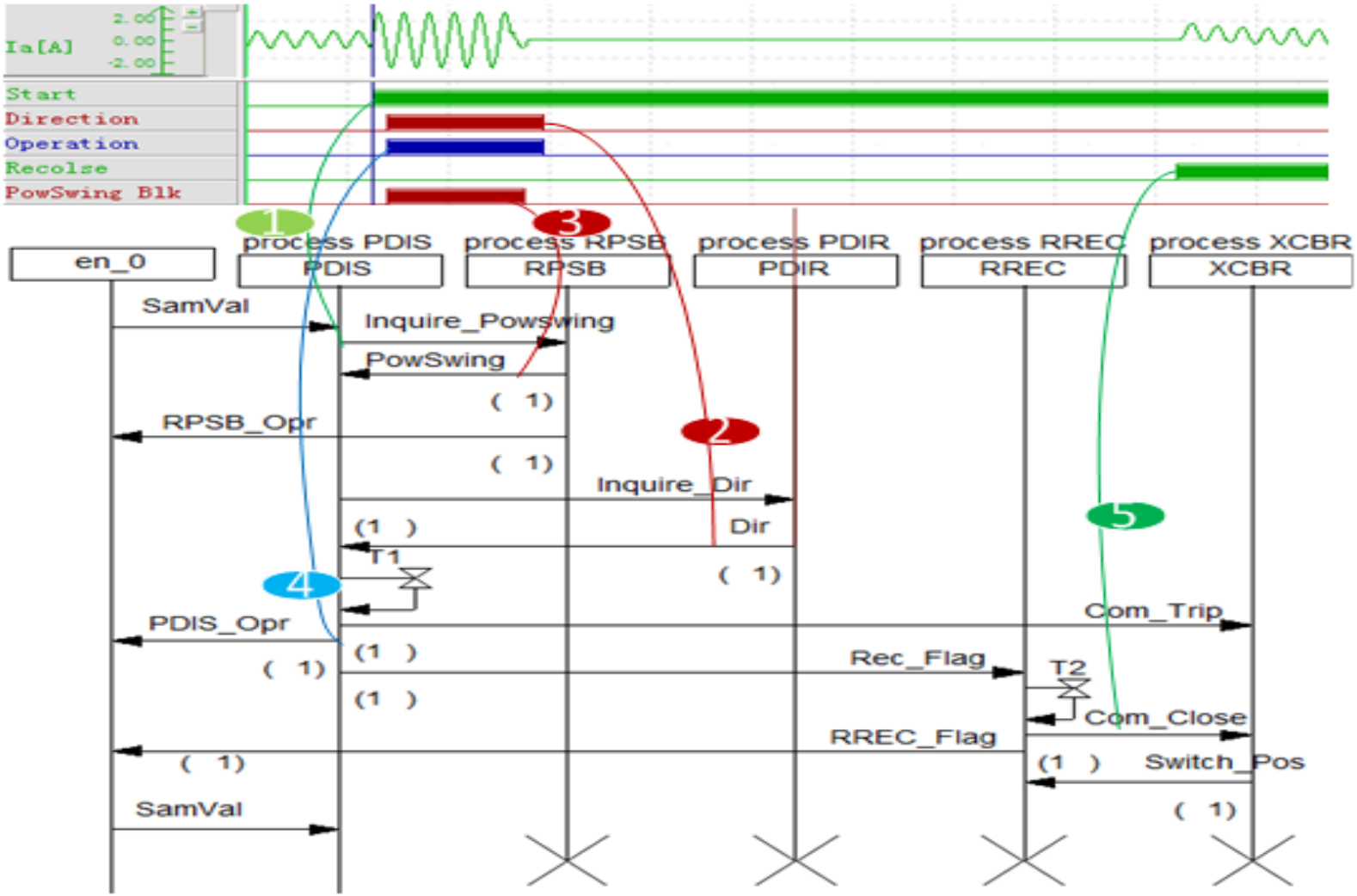
Test environment



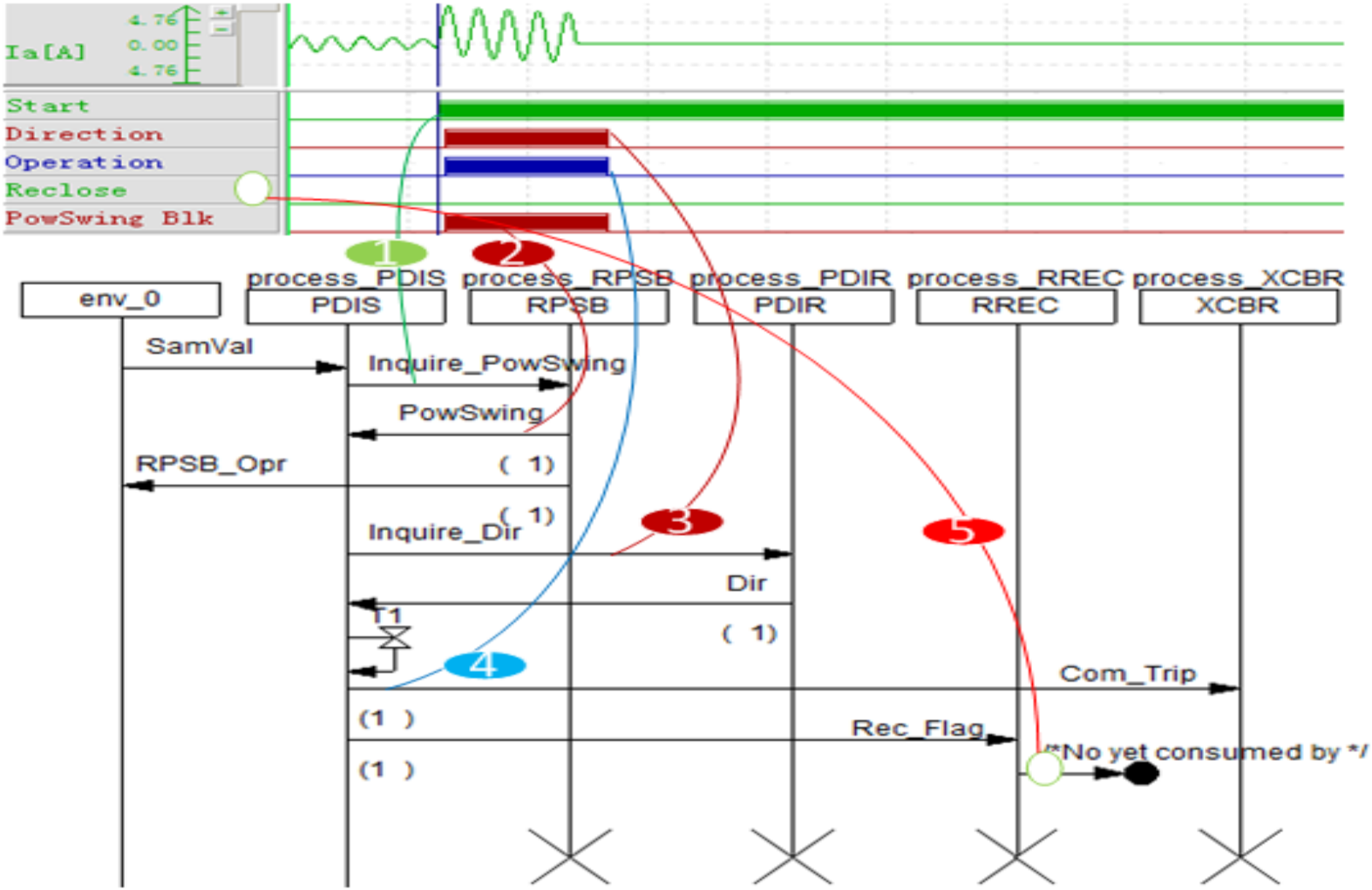
参数	取值
L_{MN}	300km
E_M	500kV, 30 degree
E_N	500kV ,0 degree
Z_{M1}	1.2+j29.4 oh
Z_{M0}	0.5+j9.0 oh
Z_{N1}	0.6+j10.4 oh
Z_{N0}	0.1+j3.0 oh
Z_{L1}	0.027+j0.2783 oh
Z_{L0}	0.1948+j0.6494 oh



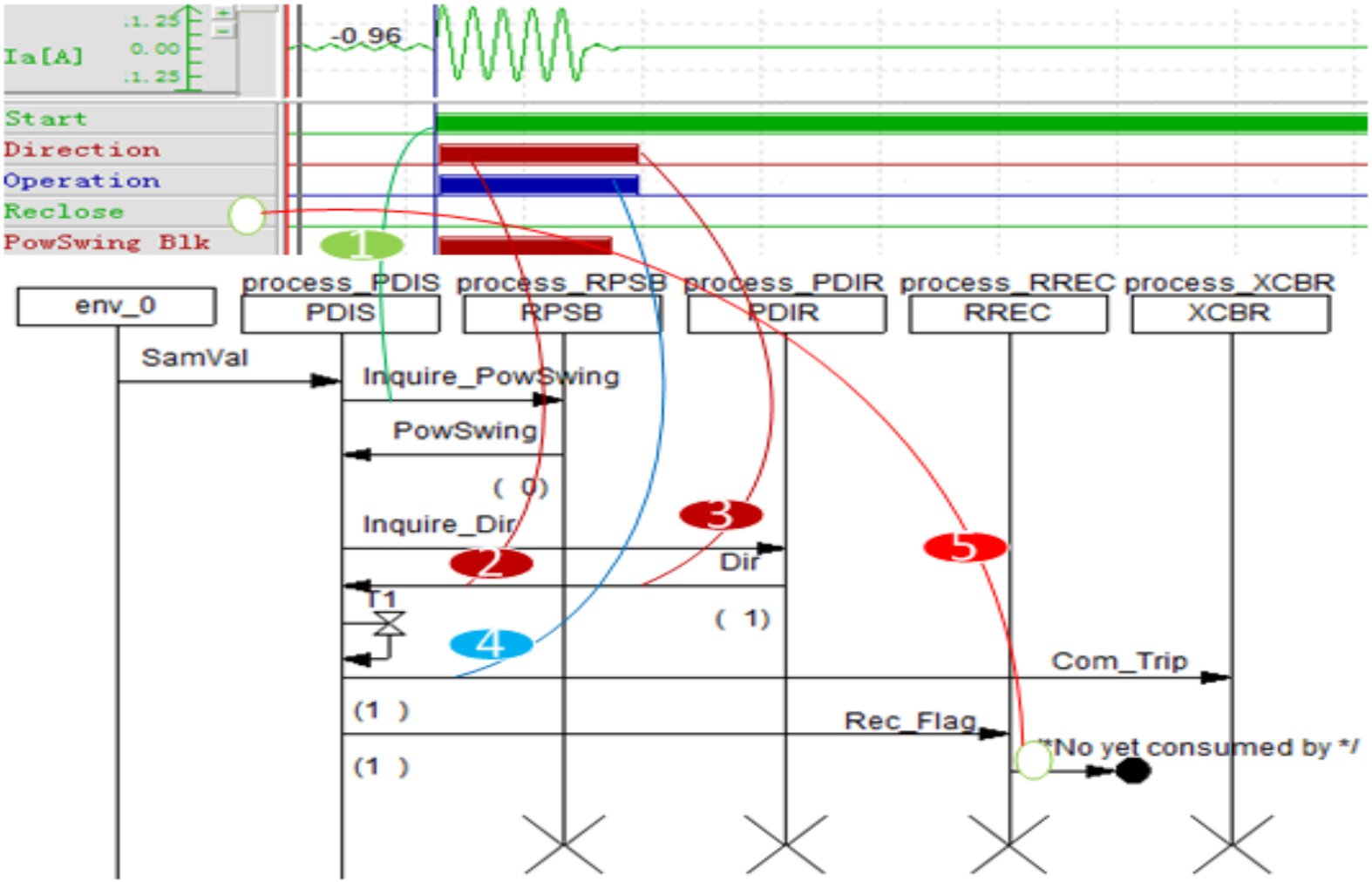
Case #1


Ia[A]
2.00
0.00
-2.00
Start
Direction
Operation
Recolse
PowSwing Blk
process PDIS
process RPSB
process PDIR
process RREC
process XCBR
en_0
PDIS
RPSB
PDIR
RREC
XCBR
SamVal
Inquire_Powswing
PowSwing
(1)
RPSB_Opr
(1)
Inquire_Dir
(1)
Dir
T1
(1)
PDIS_Opr
(1)
(1)
(1)
Com_Trip
Rec_Flag
T2
Com_Close
RREC_Flag
(1)
(1)
Switch_Pos
SamVal
(1)
1
2
3
4
5

Case #2


Ia[A]
4.76
0.00
4.76
Start
Direction
Operation
Reclose
PowSwing Blk
process_PDIS
process_RPSB
process_PDIR
process_RREC
process_XCBR
env_0
PDIS
RPSB
PDIR
RREC
XCBR
SamVal
Inquire_PowSwing
PowSwing
RPSB_Opr
(1)
(1)
Inquire_Dir
Dir
T1
(1)
Com_Trip
(1)
Rec_Flag
(1)
/*No yet consumed by */

Case #3


Ia[A]
1.25
0.00
-1.25
-0.96
Start
Direction
Operation
Reclose
PowSwing Blk
1
process_PDIS
process_RPSB
process_PDIR
process_RREC
process_XCBR
env_0
PDIS
RPSB
PDIR
RREC
XCBR
SamVal
Inquire_PowSwing
PowSwing
(0)
Inquire_Dir
3
2
Dir
5
T1
(1)
4
Com_Trip
(1)
Rec_Flag
(1)
*No yet consumed by */

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Issues to be study furtherly

- ☑ The information included within exiting model
- ☑ The granularity that graphic presentation can achieve
- ☑ The coordination design between hardware and software for relay protection
- ☑ trying to adopt TTCN to develop better use cases with high coverage

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Thanks for your attention!

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