E^3 : New ESS EPICS Environment

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December 14, 2017

Fear for E^3

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```
Fear is the path to the dark side...fear leads to anger...anger
leads to hate...hate leads to suffering.
```

Yoda

Dynamic module for EPICS : EEE, PEE[1], or E[3]

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- Quality management of IOCs
  - full freedom: good for small groups; not so good for broad provider such as ICS to many instrument developers and in-kind developers
- Common quality management problems:
  - varying quality of modules (open source): code, documentation, & styles
  - version changes of base, modules, etc.
  - platform variability
  - inconsistent version management overall in EPICS community
- Have to consider different EPICS users over ESS life time
  - advanced users: can manage their own IOC details
  - device integration focused (time limited) users: want to avoid low level development, compiling code etc.
  - less experienced users : benefit from pre-selection and prepared modules
  - core development users

[1] Unofficial name: **P**SI **E**PICS **E**nvironment

Its Benefits

- for users: avoid re-building IOCs from scratch
  - interesting for integration focused, and less experienced users
  - some IOC development effort shifts from those to core development users
- widely accepted versioning practices are realized in the ESS EPICS development,
- incompatible version combinations should be avoided if we carefully define what/how we want to use
- migration process over EPICS base versions is less likely to cause problems

This Talk is ...

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to do ..

- to describe the short term goals for **E**^{3}.
- to explain **ONLY** what the current EEE/PEE directory structure is, and its generic problem according to its structure.
- to explain what the new **E**^{3} directory structure, which could resolve the generic problem of EEE, is.
- to explain shortly the new building system for **E**^{3}

not to do

- not to explain what the current EEE/PEE problems are, and how to resolve them

Short Term Goals for E^3

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Goals

- Use the PSI require module as much as possible.
- Easy to duplicate the production **E^3** in any Linux platforms without interrupting the ESS production system.
- Keep whatever IOC running with the **minimum resources** (Money, Time, Human, Network, Disk, and so on) with the production environment
- Make the transparent system for the existent ICS services (IOC factory, CCDB, and so on).
- Keep the synchronization with Timo's technical view (See Page 3 and 4).

Subjects

- Building System (EPICS Base, EPICS Modules, and so on) by WHOM
- Maintaining System in case that what we have to update or upgrade any of EPICS BASE, EPICS Modules, and whatever.

Short Term Goals for E^3

Goals

- **However, we have to change PSI require a lot.**
- Easy to duplicate the production **E^3** in any Linux platforms without interrupting the ESS production system.
- Keep whatever IOC running with the **minimum resources** (Money, Time, Human, Network, Disk, and so on) with the production environment
- Make the transparent system for the existent ICS services (IOC factory, CCDB, and so on).
- Keep the synchronization with Timo's technical view (See Page 3 and 4).

Subjects

- Building System (EPICS Base, EPICS Modules, and so on) by WHOM
- Maintaining System in case that what we have to update or upgrade any of EPICS BASE, EPICS Modules, and whatever.
- Deploying System : **Yeah! We have Remy and Benjamin, so I don't worry!**

Current EEE/PEE structure : Directory

```
/opt/epics/
├── [iocuser   63] bases
├── [iocuser   16] java
├── [iocuser 8.0K] modules
├── [iocuser   12] require.lock-39d2d0
└── [iocuser   64] require.lock-b316e0
```

```
/opt/epics/bases/
├── [iocuser 4.0K] base-3.14.12.5
├── [iocuser 4.0K] base-3.15.2
└── [iocuser 4.0K] base-3.15.4
```

```
/opt/epics/modules/
├── [iocuser   30] acct
├── [iocuser 4.0K] adandor
├── [iocuser   98] adaravis
├── [iocuser 4.0K] adcore
├── [iocuser   18] adcsimdetector
 ..........................................
├── [iocuser   18] emu-motor
├── [iocuser   30] emu-plc
├── [iocuser 4.0K] environment
 ..................................................
├── [iocuser 4.0K] example
├── [iocuser   18] dataacquisition
├── [iocuser   66] DataAcquisition
 ..........................................................
├── [iocuser   39] wednesday
├── [iocuser   59] wienermpod
├── [iocuser   27] wienermpod-b
├── [iocuser   29] wirescanner
└── [iocuser   18] xml
```

Current EEE/PEE structure : Directory

```
/opt/epics/modules/iocStats/
├── [iocuser   54] 3.1.14
│   ├── [iocuser   26] 3.14.12.5
│   ├── [iocuser   26] 3.15.4
│   ├── [iocuser 4.0K] db
│   └── [iocuser 4.0K] opi
└── [iocuser   41] user_name
    ├── [iocuser   26] 3.14.12.5
    ├── [iocuser 4.0K] db
    └── [iocuser 4.0K] opi
```

```
/opt/epics/modules/iocStats/3.1.14/
├── [iocuser   26] 3.14.12.5
│   ├── [iocuser   25] dbd
│   └── [iocuser   27] lib
├── [iocuser   26] 3.15.4
│   ├── [iocuser   25] dbd
│   └── [iocuser   27] lib
│       └── [iocuser   46] centos7-x86_64
├── [iocuser 4.0K] db
│   ├── [iocuser 1.8K] iocAdminRTEMS.substitutions
│   ├── [iocuser 1.2K] iocAdminScanMon.substitutions
│   ├── [iocuser 1.4K] iocAdminSoft.substitutions
│   ├── [iocuser 2.6K] iocAdminVxWorks.substitutions
│   ├── [iocuser 1.1K] iocCluster.template
│   ├── [iocuser  157] iocEnvVar.template
│   ├── [iocuser 1.1K] iocGeneralTime.template
│   ├── [iocuser  632] iocRTEMSOnly.template
│   ├── [iocuser 2.5K] iocRTOS.template
│   ├── [iocuser  555] iocScanMonSum.template
│   ├── [iocuser  639] iocScanMon.template
│   ├── [iocuser 8.5K] ioc.template
│   └── [iocuser  611] iocVxWorksOnly.template
```

Current EEE/PEE structure : Directory

```
/opt/epics/modules/iocStats/
├── [iocuser   54] 3.1.14
│   ├── [iocuser   26] 3.14.12.5
│   ├── [iocuser   26] 3.15.4
│   ├── [iocuser 4.0K] db
│   └── [iocuser 4.0K] opi
└── [iocuser   41] user_name
    ├── [iocuser   26] 3.14.12.5
    ├── [iocuser 4.0K] db
    └── [iocuser 4.0K] opi
```

```
/opt/epics/modules/iocStats/3.1.14/
├── [iocuser   26] 3.14.12.5
│   ├── [iocuser   25] dbd
│   └── [iocuser   27] lib
├── [iocuser   26] 3.15.4
│   ├── [iocuser   25] dbd
│   └── [iocuser   27] lib
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│   ├── [iocuser 1.2K] iocAdminScanMon.substitutions
│   ├── [iocuser 1.4K] iocAdminSoft.substitutions
│   ├── [iocuser 2.6K] iocAdminVxWorks.substitutions
│   ├── [iocuser 1.1K] iocCluster.template
│   ├── [iocuser  157] iocEnvVar.template
│   ├── [iocuser 1.1K] iocGeneralTime.template
│   ├── [iocuser  632] iocRTEMSOnly.template
│   ├── [iocuser 2.5K] iocRTOS.template
                       ScanMonSum.template
                       ScanMon.template
                       ioc.template
                       VxWorksOnly.template
```

DB files should be under "base version"
However, it belongs to also iocStats version

Warning ..

The following few pages (page 7 and 8) are not 100% correct, but partly correct.
However with many assumptions and ignorance on different technical aspects, I would like to show the complicated situations which we will see in the near future.

Han

Current EEE/PEE structure : $\mathrm{B}_\mu \times \mathrm{R}_\nu \times \mathrm{M}_\rho$

Case 1 : Base (μ), Require (ν), One Module (ρ)

- Fact 1 : We forced users to use ONE Environment (Require) version (BASE is embedded)
- Fact 2 : Users can see other BASE, REQUIRE, BOTH versions within their IOC applications.
- Assumption 0 : Users can combine their IOC by using existent (can see) bases and modules
- Assumption 1 : all versions (μ, ν, ρ) are compatible with each others
- Assumption 2 : For 2 years, we have 2 base version ($\mu = 2$), 4 require version ($\nu = 4$), and 6 module version ($\rho = 6$)
- $\mathrm{IOC}_{\mu\nu\rho} = \mathrm{B}_\mu \times \mathrm{R}_\nu \times \mathrm{M}_\rho$
- The total number of the likely existent IOC in our EPICS environment:

$$\sum_{\mu=1}^{2} \sum_{\nu=1}^{4} \sum_{\rho=1}^{6} \mathrm{IOC}_{\mu\nu\rho} = \mathbf{48}$$

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Case 2 : Base (μ), Require (ν), N Module (ρ)

- Assumption 1 : all versions ($\mu, \nu, \rho,\ i$) are compatible with each others
- Assumption 2 : $N = 3$, we have 3 different modules
- Assumption 3 : For 2 years, we have 2 base version ($\mu = 2$), 4 requires ($\nu = 4$), and 6 module version ($\rho, \sigma, \delta = 6$) per each modules
- $\mathrm{IOC}_{\mu\nu\rho\sigma\delta} = \mathrm{B}_\mu \times \mathrm{R}_\nu \times \mathrm{M}_\rho^1 \times \mathrm{M}_\sigma^2 \times \mathrm{M}_\delta^3$
- The total number of the likely existent IOC in our EPICS environment:

$$\sum_{\mu=1}^{2}\sum_{\nu=1}^{4}\sum_{\rho=1}^{6}\sum_{\sigma=1}^{6}\sum_{\delta=1}^{6}\mathrm{IOC}_{\mu\nu\rho\sigma\delta} = \mathbf{1782}$$

Current EEE/PEE structure : $\mathrm{B}_\mu \times \mathrm{R}_\nu \times \prod_{i=1}^{N} \mathrm{M}_\rho^i$

Case 2 : Base (μ), Require (ν), N Module (ρ)

- Assumption 1 : all versions ($\mu, \nu, \rho,\ i$) are compatible with each others
- Assumption 2 : $N = 3$, we have 3 different modules
- **What about 2+ years later?**
- $\mathrm{IOC}_{\mu\nu\rho\sigma\delta} = \mathrm{B}_\mu \times \mathrm{R}_\nu \times \mathrm{M}_\rho^1 \times \mathrm{M}_\sigma^2 \times \mathrm{M}_\delta^3$
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Current EEE/PEE structure : $\mathrm{B}_\mu \times \mathrm{R}_\nu \times \prod_{i=1}^{N} \mathrm{M}_\rho^i$

Case 2 : Base (μ), Require (ν), N Module (ρ)

- Assumption 1 : all versions ($\mu, \nu, \rho,\ i$) are compatible with each others
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- $\mathrm{IOC}_{\mu\nu\rho\sigma\delta} = \mathrm{B}_\mu \times \mathrm{R}_\nu \times \mathrm{M}_\rho^1 \times \mathrm{M}_\sigma^2 \times \mathrm{M}_\delta^3$
- The total number of the likely existent IOC in our EPICS environment:

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- Are we sure how to handle them in terms of disk space, network traffic, and so on?
- How can we drop old base, require, and module versions, which no one uses?
- The assumption 1 likely is not true, we have a lot of incompatible issues among all of them. How do we fix this?

E^3 : Still ESS EPICS Environment

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```
/epics/
├── [root    4.0K]  base-3.15.5/
└── [root    4.0K]  base-3.16.1/
```

E^3 : Still ESS EPICS Environment

EUROPEAN SPALLATION SOURCE

```
/epics/
├── [root    4.0K]  base-3.15.5/
└── [root    4.0K]  base-3.16.1/
```

```
base-3.15.5/
├── [root    4.0K]  bin
├── [root    4.0K]  configure
├── [root    4.0K]  db
├── [root    4.0K]  dbd
├── [root    4.0K]  html
├── [root     12K]  include
├── [root    4.0K]  lib
├── [root    4.0K]  require
├── [root    4.0K]  startup
└── [root    4.0K]  templates
```

Require module has the dependency upon EPICS Base, so we put them under each EPICS Base version

E^3 : Still ESS EPICS Environment

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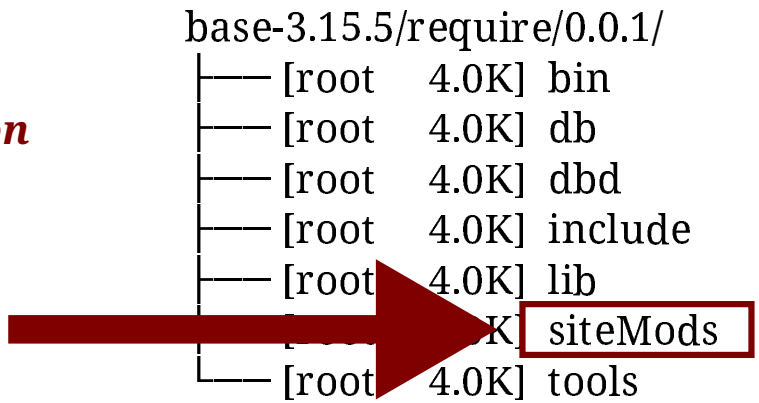
Each module has dependency upon a require module version, so we put them under a require version




```
base-3.15.5/
├── [root    4.0K]  bin
├── [root    4.0K]  configure
├── [root    4.0K]  db
├── [root    4.0K]  dbd
├── [root    4.0K]  html
├── [root     12K]  include
├── [root    4.0K]  lib
├── [root    4.0K]  require
├── [root    4.0K]  startup
└── [root    4.0K]  templates
```

```
base-3.15.5/require/
├── [root    4.0K]  0.0.0
├── [root    4.0K]  0.0.1
└── [root    4.0K]  2.5.4
```

E^3 : Still ESS EPICS Environment

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```
base-3.15.5/require/0.0.1/
├── [root     4.0K]  bin
│   ├── [root      20]  ess-env.conf
│   ├── [root     2.3K]  iocsh.bash
│   ├── [root     6.6K]  iocsh_functions
│   └── [root     2.8K]  setE3Env.bash
├── [root     4.0K]  db
│   └── [root      661]  moduleversion.template
├── [root     4.0K]  dbd
│   └── [root      146]  require.dbd
├── [root     4.0K]  include
│   ├── [root      390]  asprintf.h
│   ├── [root      697]  require.h
│   └── [root      177]  strdup.h
├── [root     4.0K]  lib
│   ├── [root     4.0K]  linux-ppc64e6500
│   │   ├── [root      78K]  librequire.so
│   │   └── [root       68]  require.dep
│   └── [root     4.0K]  linux-x86_64
│       ├── [root     141K]  librequire.so
│       └── [root       68]  require.dep
├── [root     4.0K]  siteMods
│   └── [root     4.0K]  iocStats
│       ├── [root     4.0K]  0.0.1
│       └── [root     4.0K]  develop
└── [root     4.0K]  tools
    ├── [jhlee     38K]  driver.makefile
    ├── [root     3.2K]  expandDBD.tcl
    └── [root     7.9K]  getVersion.tcl
```

iocsh.bash
setE3Env.bash
per a version of require

makefile, and other scripts
per a version of require

E^3 : Still ESS EPICS Environment

```
base-3.15.5/require/0.0.1/siteMods/
└── [root     4.0K]  iocStats
    ├── [root     4.0K]  0.0.1
    │   ├── [root     4.0K]  db
    │   ├── [root     4.0K]  dbd
    │   ├── [root     4.0K]  include
    │   └── [root     4.0K]  lib
    └── [root     4.0K]  develop
        ├── [root     4.0K]  db
        ├── [root     4.0K]  dbd
        ├── [root     4.0K]  include
        └── [root     4.0K]  lib
```

DB files belong to its version

```
base-3.15.5/require/0.0.1/siteMods/iocStats/0.0.1/
├── [root     4.0K]  db
│   ├── [root      2.0K]  access.db
│   ├── [root      1.1K]  iocCluster.template
│   ├── [root       157]  iocEnvVar.template
│   ├── [root      1.1K]  iocGeneralTime.template
│   ├── [root       632]  iocRTEMSOnly.template
│   ├── [root      2.5K]  iocRTOS.template
│   ├── [root       555]  iocScanMonSum.template
│   ├── [root       639]  iocScanMon.template
│   ├── [root      8.5K]  ioc.template
│   └── [root       611]  iocVxWorksOnly.template
├── [root     4.0K]  dbd
│   └── [root       418]  iocStats.dbd
├── [root     4.0K]  include
│   ├── [root      3.4K]  devIocStats.h
│   └── [root       946]  devIocStatsOSD.h
└── [root     4.0K]  lib
    ├── [root     4.0K]  linux-ppc64e6500
    │   ├── [root       31]  iocStats.dep
    │   └── [root      69K]  libiocStats.so
    └── [root     4.0K]  linux-x86_64
        ├── [root       31]  iocStats.dep
        └── [root     151K]  libiocStats.so
```

E^3 : From t_0 to t_1

t_0

```
├── [jhlee    4.0K]  base-3.15.5
│   ├── [jhlee    4.0K]  bin
│   ├── [jhlee    4.0K]  require
│   │   ├── [jhlee    4.0K]  2.5.4
│   │   │   ├── [jhlee    4.0K]  bin
│   │   │   ├── [jhlee    4.0K]  db
│   │   │   ├── [jhlee    4.0K]  dbd
│   │   │   ├── [jhlee    4.0K]  include
│   │   │   ├── [jhlee    4.0K]  lib
│   │   │   ├── [jhlee    4.0K]  siteApps
│   │   │   ├── [jhlee     12K]  siteLibs
│   │   │   ├── [jhlee    4.0K]  siteMods
│   │   │   ├── [jhlee    4.0K]  siteSthElse
│   │   │   └── [jhlee    4.0K]  tools
│   │   ├── [jhlee    4.0K]  2.5.9
│   │   │   ├── [jhlee    4.0K]  bin
│   │   │   ├── [jhlee    4.0K]  db
│   │   │   ├── [jhlee    4.0K]  dbd
│   │   │   ├── [jhlee    4.0K]  include
│   │   │   ├── [jhlee    4.0K]  lib
│   │   │   ├── [jhlee    4.0K]  siteApps
│   │   │   ├── [jhlee     12K]  siteLibs
│   │   │   ├── [jhlee    4.0K]  siteMods
│   │   │   ├── [jhlee    4.0K]  siteSthElse
│   │   │   └── [jhlee    4.0K]  tools
```

```
│   │   └── [jhlee    4.0K]  3.6.7
│   │       ├── [jhlee    4.0K]  bin
│   │       ├── [jhlee    4.0K]  db
│   │       ├── [jhlee    4.0K]  dbd
│   │       ├── [jhlee    4.0K]  include
│   │       ├── [jhlee    4.0K]  lib
│   │       ├── [jhlee    4.0K]  siteApps
│   │       ├── [jhlee     12K]  siteLibs
│   │       ├── [jhlee    4.0K]  siteMods
│   │       ├── [jhlee    4.0K]  siteSthElse
│   │       └── [jhlee    4.0K]  tools
```

E3 status at time t_0

E^3 : From t_0 to t_1

t_0

```
├── [jhlee    4.0K]  base-3.15.5
│   ├── [jhlee    4.0K]  bin
│   ├── [jhlee    4.0K]  require
```

E3 Status at time t_1

We can drop old require versions in base-3.15.5, that means all old modules below them also we can drop.

Or, we can seperate old E3 easily, in case we can use only them to run old IOC, if the ioc has no issue with limited network and disk resources.

```
│   │   └── [jhlee    4.0K]  3.6.7
│   │       ├── [jhlee    4.0K]  bin
│   │       ├── [jhlee    4.0K]  db
│   │       ├── [jhlee    4.0K]  dbd
│   │       ├── [jhlee    4.0K]  include
│   │       ├── [jhlee    4.0K]  lib
│   │       ├── [jhlee    4.0K]  siteApps
│   │       ├── [jhlee     12K]  siteLibs
│   │       ├── [jhlee    4.0K]  siteMods
│   │       ├── [jhlee    4.0K]  siteSthElse
│   │       └── [jhlee    4.0K]  tools
├── [jhlee    4.0K]  base-3.16.1
│   ├── [jhlee    4.0K]  bin
│   ├── [jhlee    4.0K]  require
│   │   ├── [jhlee    4.0K]  2.5.9
│   │   ├── [jhlee    4.0K]  3.6.7
│   │   └── [jhlee    4.0K]  3.6.8
├── [jhlee    4.0K]  base-7.0.0
│   ├── [jhlee    4.0K]  bin
│   ├── [jhlee    4.0K]  require
│   │   ├── [jhlee    4.0K]  3.6.7
│   │   ├── [jhlee    4.0K]  4.0.0
│   │   └── [jhlee    4.0K]  5.0.0
```

t_1

Warning ..

The following few pages (page 12 and 13) are not 100% correct, but partly correct.
However with many assumptions and ignorance on different technical aspects, I would like to show the complicated situations which we will see in the near future.

Han

Future E^3 structure : $B_1 \times R_1 \times M_\rho$

Case 1 : Base (μ), Require (ν), One Module (ρ)

- Fact 1 : We ask or force users to use a BASE **AND** a Require version.
- Fact 2 : We can allow users to change its base **AND** and require version also.
- Fact 3 : Users cannot see other BASE and REQUIRE within their IOC application.
- Assumption 1 : For 2 years, we have 2 base version ($\mu = 2$), 4 require version ($\nu = 4$), and 6 module version ($\rho = 6$)
- $\mathrm{IOC}_{11\rho} = \mathrm{B}_1 \times \mathrm{R}_1 \times \mathrm{M}_\rho$
- The total number of the likely existent IOC (IOC has no idea about other BASE and require versions :

$$\sum_{\rho=1}^{6} \mathrm{IOC}_{11\rho} = \mathbf{6}$$

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Case 2 : Base (μ), Require (ν), N Module (ρ)

- Assumption 1 : all versions ($\mu, \nu, \rho,\ i$) are compatible with each others
- Assumption 2 : $N = 3$, we have 3 different modules
- Assumption 3 : For 2 years, we have 2 base version ($\mu = 2$), 4 requires ($\nu = 4$), and 6 module version ($\rho, \sigma, \delta = 6$) per each modules
- $\mathrm{IOC}_{11\rho\sigma\delta} = \mathrm{B}_1 \times \mathrm{R}_1 \times \mathrm{M}_\rho^1 \times \mathrm{M}_\sigma^2 \times \mathrm{M}_\delta^3$
- The total number of the likely existent IOC in our EPICS environment:

$$\sum_{\rho=1}^{6} \sum_{\sigma=1}^{6} \sum_{\delta=1}^{6} \mathrm{IOC}_{11\rho\sigma\delta} = \mathbf{216}$$

Current E^3 Status

Stage 1 : E^3

- Design the Building System (Setup and Development Modes)
- Support any generic Linux well (tested with Debian 8/9, CentOS 7.4, Ubuntu 16/17, Rasberian Strech)
- Rewrite the iocsh, now iocsh.bash instead of iocsh, because it is the bash shell, not an executable file.
- Minor modification on PSI require modules (driver.makefile and require source files)
- However, it has the same directory structure, which EEE has one
- Few testbeds are running with the current version (Timing IOCs, EtherCAT IOC, ipmiComm IOC, OPC UA IOC)

EUROPEAN SPALLATION SOURCE

Startup Script Example for ipmiComm IOC

```
require asyn, 4.32.0
require ipmiComm, 4.0.2
require iocStats, 1856ef5


epicsEnvSet("ENGINEER","hanlee x3409")
epicsEnvSet("LOCATION","Rack 1 at ICS Tuna Lab")

epicsEnvSet("IOC", "TunaLab-ipmiTest")

epicsEnvSet("DEV", "$(IOC):R03-DAQ02")
epicsEnvSet("IPPORT_MCH", "10.4.8.123:623 udp")
epicsEnvSet("LOCATION", "ICS Tuna Lab")
epicsEnvSet("NAME", "NAT MCH")


# iocStats
dbLoadRecords("iocAdminSoft.db", "IOC=$(IOC):IocStats")

drvAsynIPPortConfigure ("nat-mch123", "${IPPORT_MCH}",0,0,0)

mchInit("nat-mch123")

dbLoadRecords("shelf_microtca_12slot.db","dev=$(DEV),link=nat-mch123,location=$(LOCATION)")

iocInit()
```

Future E^3 Plan

Stage 2 : E^3

- Redesign the Building System (similar approach to EPICS Building System)
- Heavily modified PSI makefile
- Work in progress
- Target Due Date : early March, 2018

Stage 3 : E^3+

- Maybe we can use the EPICS building system instead of the require.makefile
- Complete rewrite the PSI require module. So ESS will its own require module[2]
- Collect possible technical resources, design, and discuss its requirements
- Target Due Date : March, 2020

[2] The module name is under discussion

Clone It Today!

EUROPEAN SPALLATION SOURCE

You can get the glimpse of $\mathbf{E}^3$ via

```
git clone https://github.com/icshwi/e3
```

Questions?

EUROPEAN SPALLATION SOURCE

Computers are useless. They can only give you answers.

Pablo Picasso

Much to learn you still have ... my old padawan. This is just the beginning!

Yoda

Tack!

감사합니다!

Thank you!

Dankeschön!

¡Gracias!

Grazie!

Merci!

Kiitos!

☺