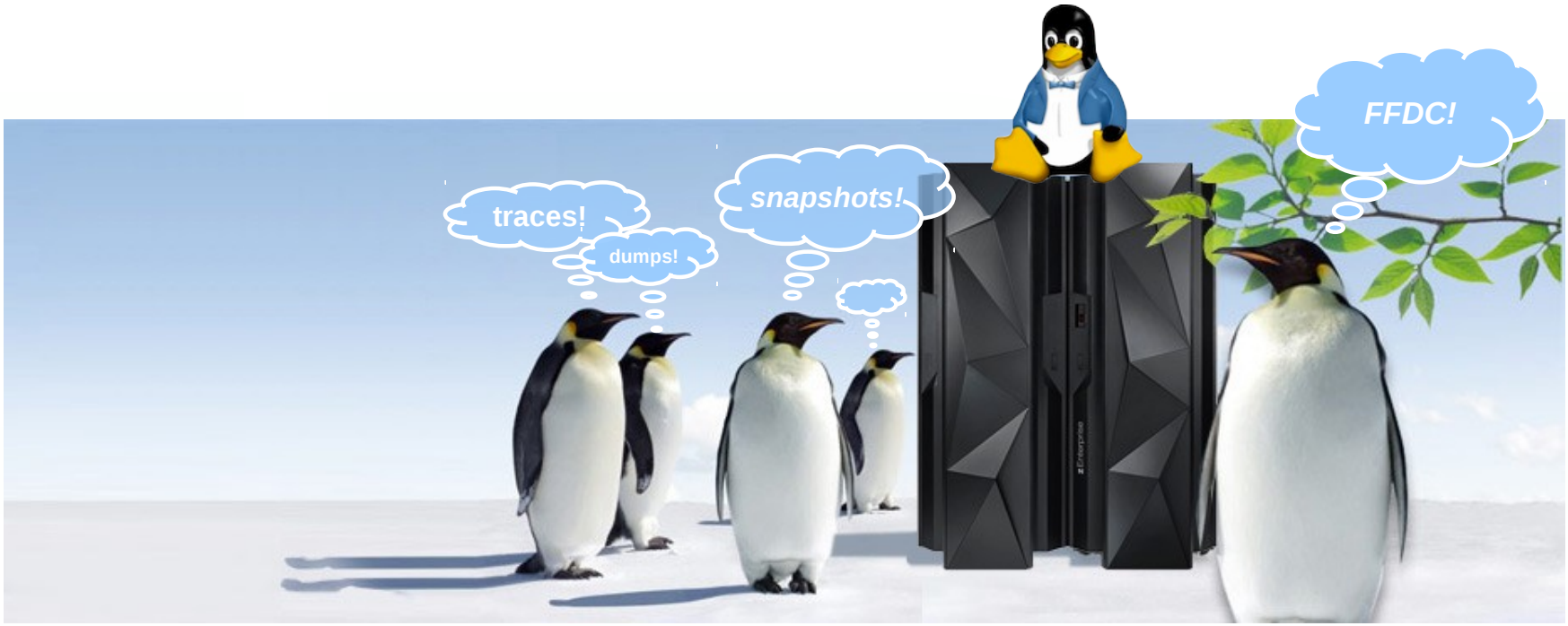
First Failure Data Capture (FFDC) for Linux



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The FFDC Concept

Proposal

Action Plan

Motivation

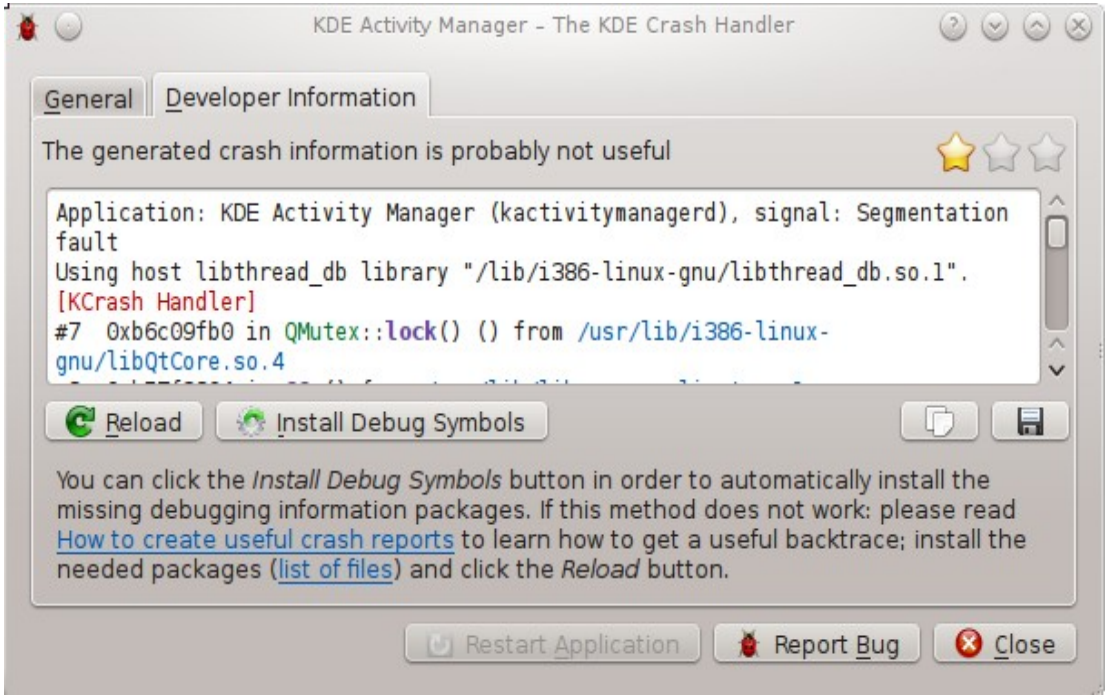
- **A symptom was detected**
  - Which problem lead to the symptom?
  - In which component did the problem occur?
  - What was the root cause for the problem?
  - Which sequence of operations triggered to the problem?
- **Current approach**
  - Live debugging
  - Increase debug levels
  - Do additional tests with the system
  - Reproduce problem
- **What if this is not possible? (enterprise server, embedded...)**
  - *Automatically record* the required information
  - Always *collect enough information* to reconstruct the history of the error
  - FFDC is a concept to achieve this

What is FFDC? 65500?

- **FFDC = First Failure Data Capture**
- **In case of a problem**
  - The problem is detected (automatically)
  - All data needed to analyze the problem is available
  - Data gets collected immediately after problem symptom detection
- **Data for the *first* occurrence of a problem must be preserved**
- **FFDC data collection executes in rare cases**
- **Working FFDC means, no need to ...**
  - replay a problem situation
  - configure any FFDC setting
- **FFDC must be available for all relevant components of your product**
  - Relevant kernel components
  - Relevant user space processes

Examples for available FFDC

- **Android:**
  - Crash reports
  - Stack backtrace
- **KDE bug reports**
- **Windows blue screen:**
  - IBM bluescreen capturing
- **Linux manual FFDC:**
  - Redhat: sosreport
- **System z firmware:**
  - IQYYLOG and SE
  - Call home



Constraints

- **FFDC is only possible by adding overhead**
- **FFDC overhead must not cost too many resources**
  - limited time to recovery
  - limited CPU usage
  - limited memory usage
  - limited disk storage usage
  - limited network bandwidth
- **2% overhead for all resources might be acceptable?**

What do we need for FFDC?

- **Perfect: (?)**
  - **Get *all* data**
    - Record *every state change*
    - Dump *complete state*
  - **Detect *all* possible errors**
- **Doable:**
  - **Get *relevant* data**
    - History: *Trace* component entry/exit points with relevant parameters
    - State: *Dump* component control structures
    - Partitioning/Relationship: Collect only data for *affected components*
  - **Detect *relevant* errors**
    - Define *error classes & actions*
    - Define what has to be collected for which error class
- **Advantages of doable approach:**
  - Reduced runtime overhead, downtime & disruptiveness
  - Less data to analyze

What we have?
Types of debugging data

- **Logs**:
  Short messages written by a running system to ***non-volatile storage*** cover whole history of the system (or at least a ***long period***). Includes events known to have ***long term relevance*** (e.g. configuration changes). Log messages are targeted primarily at ***system administrators.***
- **Traces**:
  A trace provides a means to create a component-local sequence of timestamped short entries related to events that may be ***relevant for debugging purposes***. A trace often is ***not persistent*** (wrap-around buffers). ***Single trace entries*** may have ***no relevance***. Traces can have a ***high frequency***.
- **Dumps**:
  Point-in-time ***copy of the state*** (memory, registers) of a process or operating system which is created ***without assistance of the component*** being dumped. Examples for dumps: core dump (user space), kdump (operating system dump)

What is missing?
Types of debugging data

- **Component state-save (snapshot/dump):**
  Component-assisted ***point-in-time copy*** of ***selected component-internal state*** data, annotated with meta-data.
- **FFDC Log**:
  The FFDC Log provides a means to create a global sequence of timestamped messages related to ***events*** that may be ***relevant for debugging purposes***. The FFDC log is ***persistent***. FFDC log messages are ***targeted at developers*** or service personal, not primarily system administrators.
- **FFDC Statistics:**
  Aggregated counters or counter rate. ***Used to reduce trace data*** amount. Not the same as performance statistics.

What is missing?
FFDC transport and repository mechanism

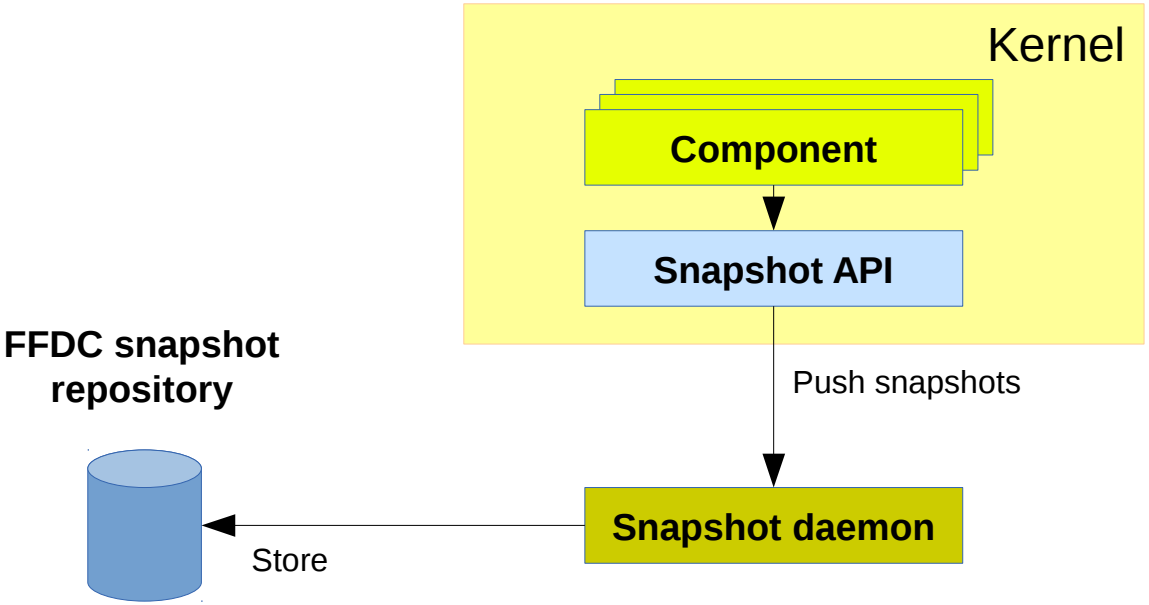
- **FFDC snapshots**
  - Persistent collection of debugging data including descriptive meta-data
  - Snapshots can contain all kinds of debugging data (logs, traces, state save, dumps).
- **FFDC repository**
  - Persistent data store for FFDC snapshots
  - Interface to manage (list, delete, report...) snapshots
- **FFCD snapshot API**
  - For transport of debugging data to FFDC repository
  - Kernel API
  - User space API (library, CLI, different language bindings)

What is FFDC?

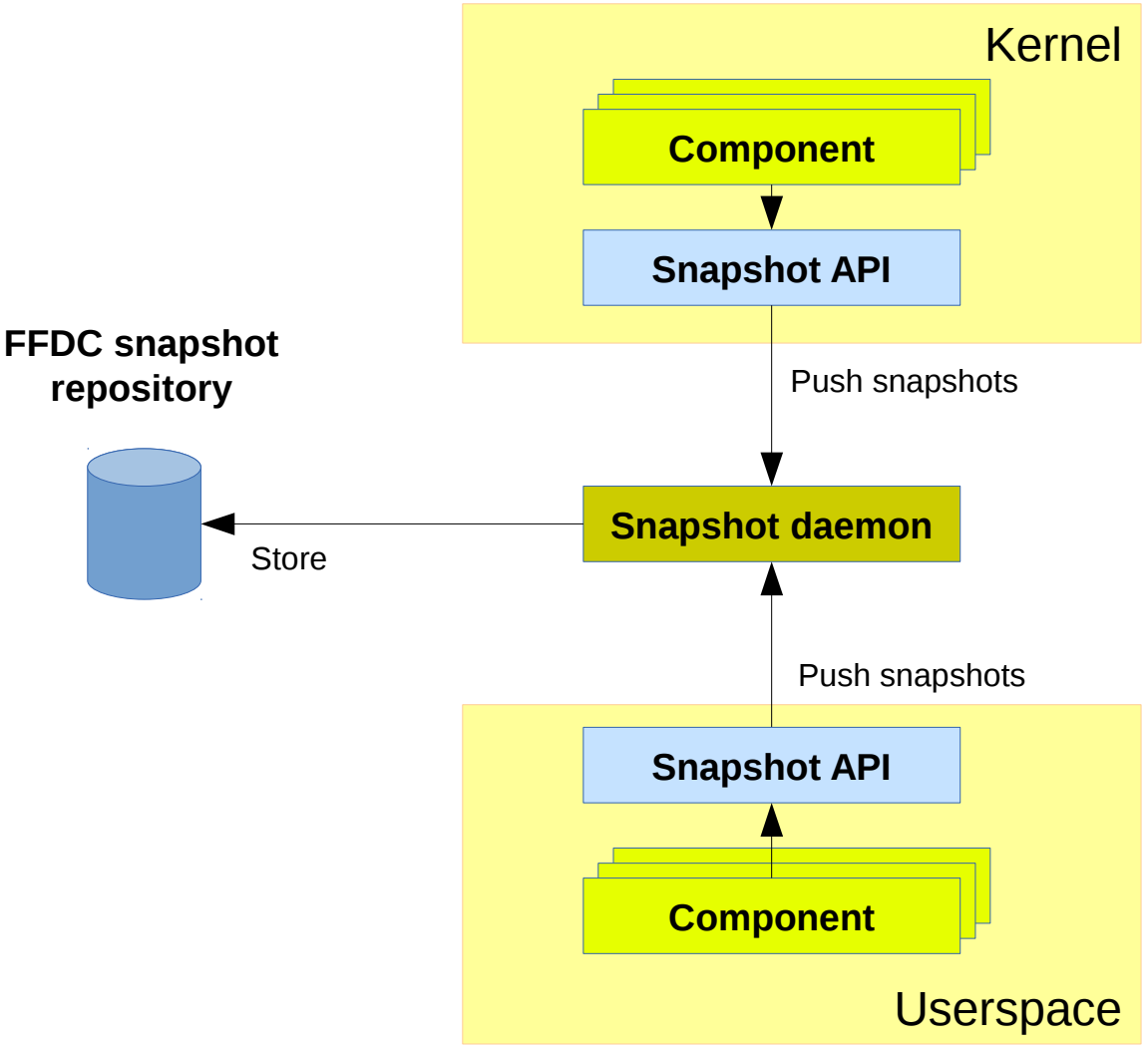
Proposal

Action Plan

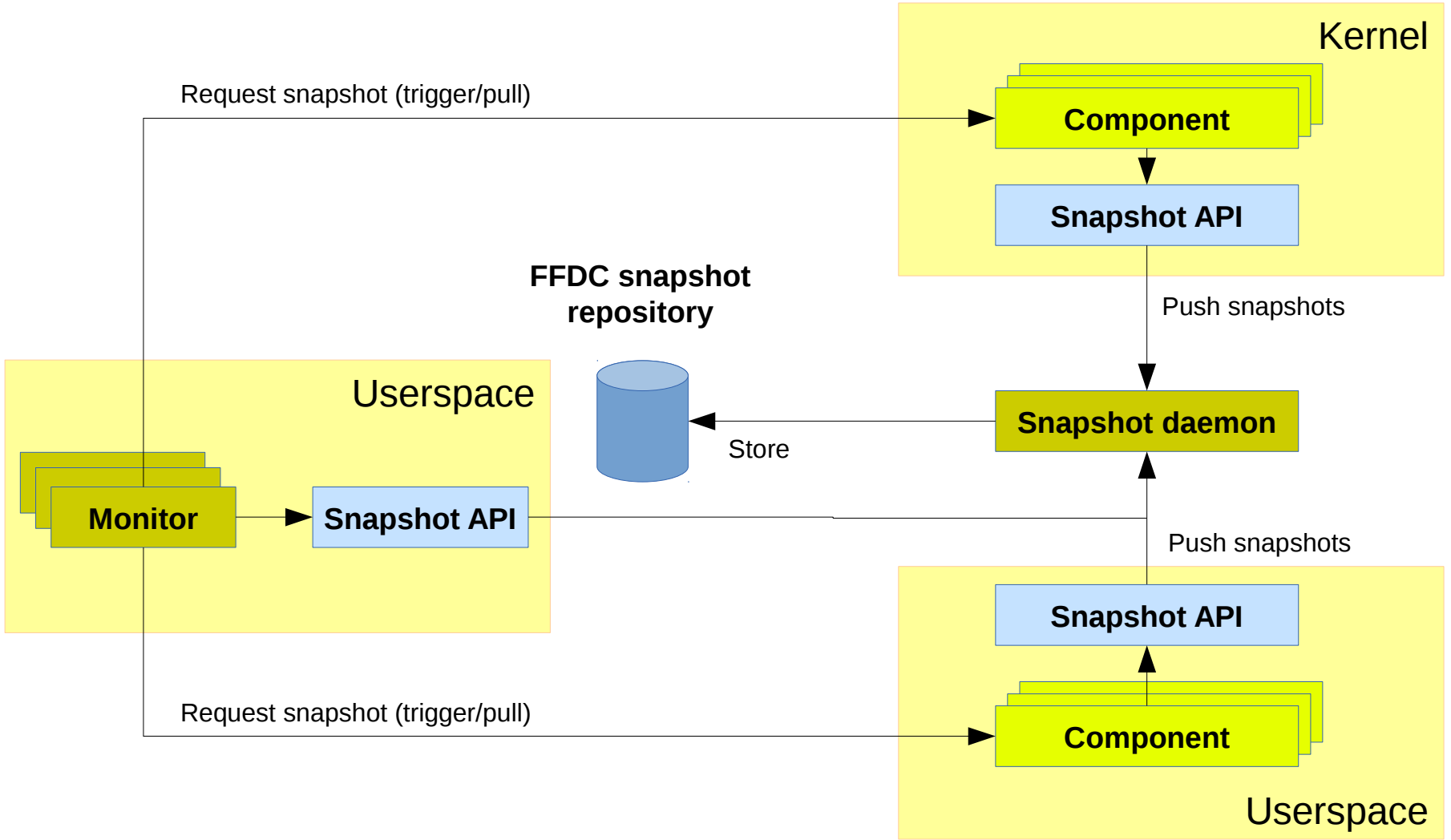
FFDC snapshot runtime



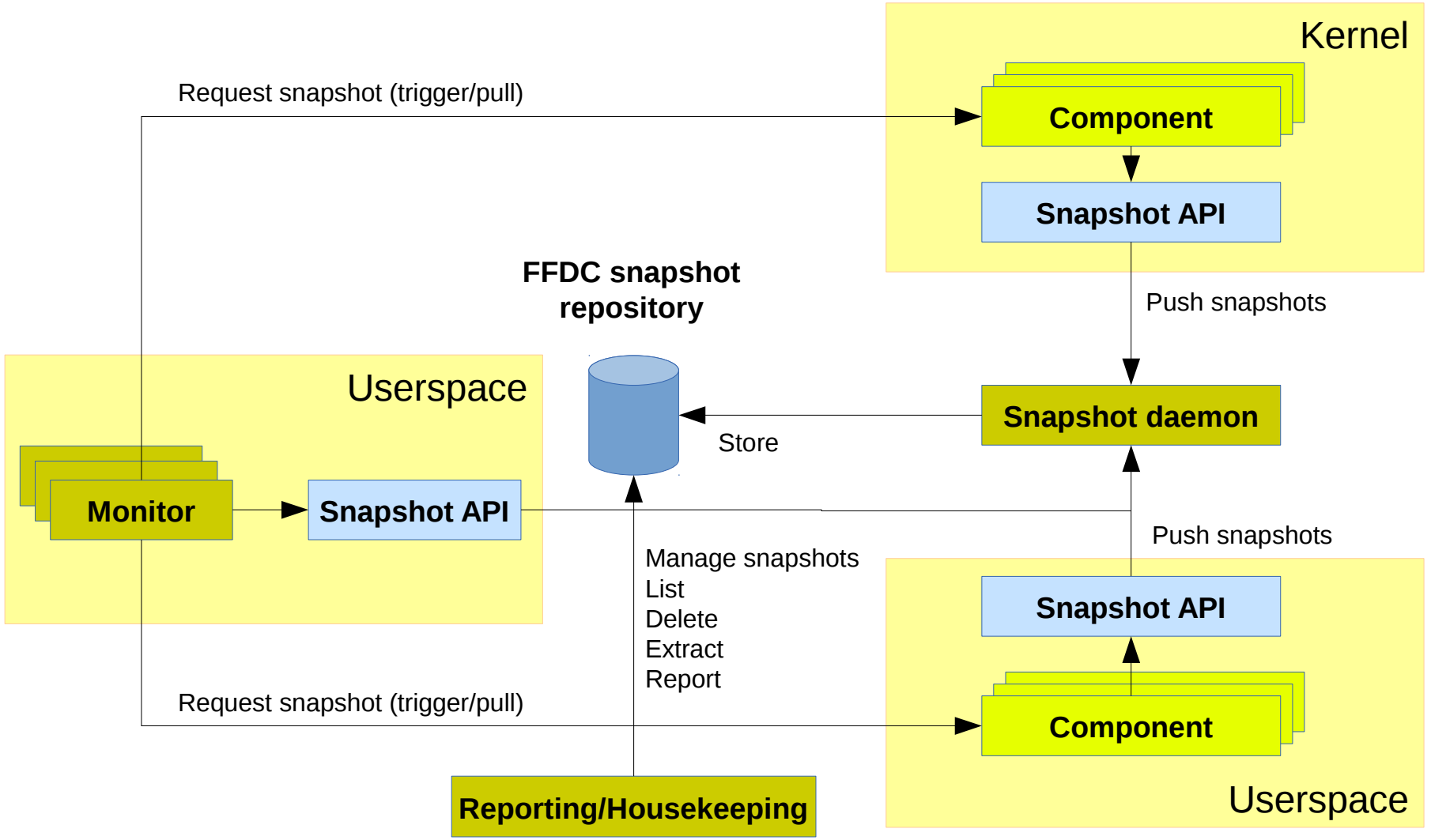
FFDC snapshot runtime



FFDC snapshot runtime



FFDC snapshot runtime



FFDC snapshot/state-save API

- **Register FFDC component (struct ffdc_info)**

```
struct ffdc_info
struct ffdc_info *ffdc_register(const char *id, ...);
```

- **Create snapshot (struct ffdc_snap)**

```
struct ffdc_snap;
struct ffdc_snap *ffdc_snap_begin(struct ffdc_info *ffdc_info,
const char *reason, ...);
void ffdc_snap_add_meta(struct ffdc_snap *ffdc_snap, const char
*key, const char *value, ...);
void ffdc_snap_add_blob(struct ffdc_snap *ffdc_snap, const char
*type, void *buf, size_t len);
void ffdc_snap_end(struct ffdc_snap *ffdc_snap);
```

- **FFDC snapshot callback (ffdc_snap_cb)**

```
typedef void (*ffdc_snap_cb)(struct ffdc_snap *snap, void *data);
int ffdc_snap_register(struct ffdc_info *ffdc_info, ffdc_snap_cb
snap_cb, void *data);
```

Kernel component snapshot/state-save

- **Saves relevant component state**
- **Consistent data view (uses component locking)**
- **Debugfs: /sys/kernel/debug**
  - **Kernel component initiated**
    - ffdc/snapshot_stream
    - Read by snapshot daemon
  - **User space initiated (e.g. by a monitor)**
    - ffdc/<component>/snapshot
    - Uses snapshot callback
- **Key/value ASCII meta data + binary data**
- **CPIO archive**

```
<component>/<timestamp>/meta
                        0.blob
                        0.meta
                        1.blob
                        1...
```

What is FFDC?

Proposal

Action Plan

What to do for better Linux FFDC?

- **Define *FFDC recommendations***
  - Which tracepoints should be enabled?
  - How much overhead is acceptable?
  - Which error classes?
- ***Enable traces* for FFDC**
  - Define initial trace settings
  - Allow access for snapshots
- **Define *component relationship* and *namespace***
- **Define relevant *component state* (state-save)**
- **Define *snapshot transport***
  - snapshot API, runtime and repository

Thank you!