Core binding with affinity mask and threads management in FIX Antenna C++ products

Affinity mask settings

The Antenna allows users to change affinity masks for threads with different purposes. This allows the application to run functionality on a critical path at dedicated threads/CPU cores. It results in response time spreading reduction and helps to keep it minimal.

FIX Antenna C++ supports affinity masks up to 64 cores

FIX Antenna C++ threads:

- dedicated threads for session processing
  - SendCpuAffinity
  - RecvCpuAffinity
  - CpuAffinity
- threads pool dedicated to messages processing that is sharable between all sessions
  - WorkerCpuAffinity
- auxiliary antenna threads
  - HelperCpuAffinity
- Note: uncontrollable threads, e.g some timers

FIX Antenna C++ supports various affinity configuration formats: Decimal, Hexadecimal, Cores-set formats.

> NOTE: Some of the affinity masks don't use for FAST sessions

Affinity is specified as bitmask where a serial number of the bit is the serial number of the core.
The default value is 0. It means that the engine will not change the thread affinity mask.

Application properties

- mask for all worker pool threads

```
WorkerCpuAffinity = 0
```

- mask for dispatcher and other auxiliary threads

```
HelperCpuAffinity = 0
```

Session properties

- mask for dedicated sending thread of a session. It makes sense only for an aggressive send mode

```
Session.Default.SendCpuAffinity = 0
```

- mask for the dedicated receiving thread of a session. It makes sense only for an aggressive receive mode

```
Session.Default.RecvCpuAffinity = 0
```

- mask for dedicated threads of a session. It makes sense only for aggressive modes

```
Session.Default.CpuAffinity = 0
```

Supported affinity formats

1. **Decimal**

```
WorkerCpuAffinity = 31
```

The setting above exposes cores #0,1,2,3,4
(see Backward compatibility)

2. **Hexadecimal**

> Introduced in FA C++ 2.27.1

```
WorkerCpuAffinity = 0x1F3A
```

The setting above exposes cores #1,3,4,5,8,9,10,11,12

3. **Cores-set format (like Linux' taskset command)**

> Introduced in FA C++ 2.27.1

```
# core numbers: integer values of set [0..63]
Session.Default.RecvCpuAffinity = 2-4

# separator character: ','
HelperCpuAffinity = 1,4

# grouping characters: '{' '}'
WorkerCpuAffinity = {0}
```

The settings above expose cores respectively #2,3,4; #1,4; #0;

> NOTE: To avoid erroneous reading with the cores-set format, use a grouping of characters in case of single-core in the mask:
>
> WorkerCpuAffinity = 31 - it means cores #0,1,2,3,4
>
> WorkerCpuAffinity ={31} - it means core #31

Support ranges

- Use comma-separated list instead of bitmask (decimal values in the range [0..63] separated by comma)

```
Session.Default.RecvCpuAffinity = {1,3,4,5,8,9,10,11,12}
```

- Supports ranges (like Linux' taskset command)

```
Session.Default.RecvCpuAffinity = 1,3-5,8-12
```

- Supports initializing list brackets to separate sense groups

```
Session.Default.RecvCpuAffinity = {1,3-5,7},{12-15}
```

Backward compatibility

The new implementation does not affect the old version of the configuration.

The old Decimal and taskset-like formats have a different meaning of single number value.
For any conflicting cases please use curly brackets '{}' notation.

by default - the decimal format is used.

Examples of conflicting configuration:

```
# The new settings uses core #2
WorkerCpuAffinity = 4
WorkerCpuAffinity = 0x4
WorkerCpuAffinity = {2}


# The old behavior uses cores # 1, 2, 3. Not using core #0
WorkerCpuAffinity = 14
# The old behavior uses cores #0
WorkerCpuAffinity = 1

# The new behavior uses cores #2 and #4
WorkerCpuAffinity = 0x14
# The new behavior uses core #14
WorkerCpuAffinity = {14}
# The new behavior uses core #2 and #4
WorkerCpuAffinity = {2,4}

# The old behavior means all cores for mapping (default)
WorkerCpuAffinity = 0
# The new behavior uses core #0
WorkerCpuAffinity = {0}
# The new representation to map all cores:
WorkerCpuAffinity = {0-63}
WorkerCpuAffinity = 0xFFFFFFFFFFFFFFFF
```

Troubleshooting

The output format for affinity in logs and other outputs in decimal style:

- The correct Affinity value:

```
[INFO]  20200127-10:46:21.703 [13888] [Engine] - WorkerCpuAffinity = {1-3}
[INFO] 20200127-10:30:46.303 [11448] [Engine] - Session <ESVR, CTG> : New session created CpuAffinity = 0
```

- The incorrect value/range for Affinity value:

```
[ERROR] Affinity parse error at pos=1 : token value '2147483647' exceeds the range [0..63]
[ERROR] Affinity parse error at pos=1 : token can not be parsed as integer inp: {abc}
```

- The incorrect interval of Affinity value:

```
[ERROR] Affinity parse error at pos=0 : token is neither interval nor decimal value inp: 1.3,4/5
```

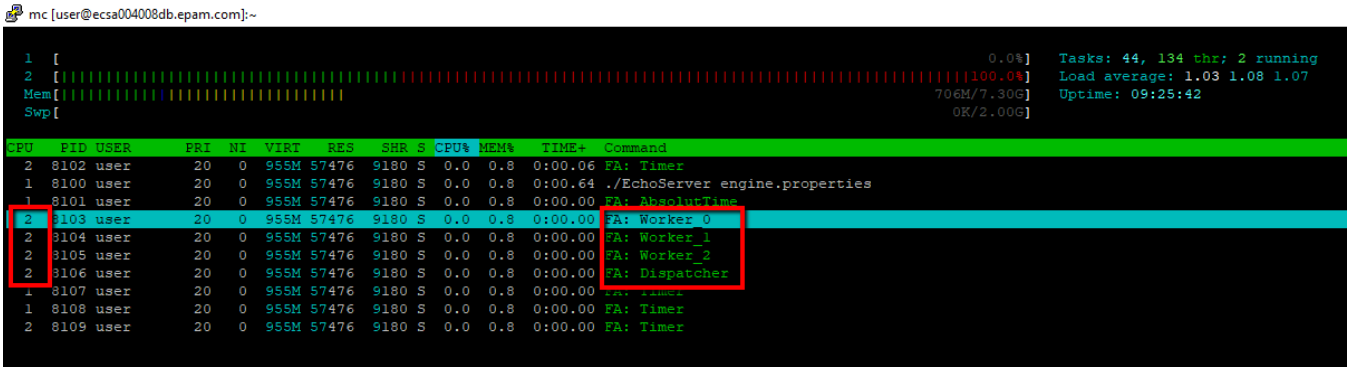
How to get information about threads

Example configuration engine.properties of FIX Antenna C++ application (e.g. EchoServer, SimpleClient samples)

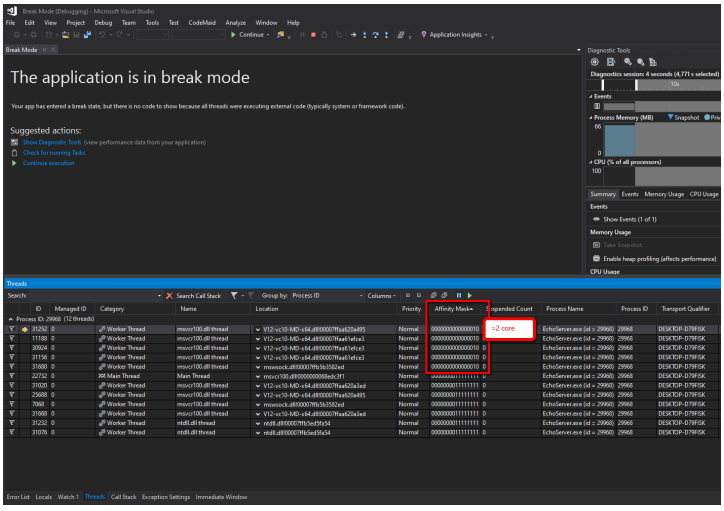
```
WorkerCpuAffinity = {1}   #(it's Worker# in CPU)
HelperCpuAffinity = {1}    #(it's Dispetcher in CPU)
```

Check assigned CPU cores in Linux using htop:

```
$ htop -p `pidof EchoServer`
```



Check assigned CPU cores in Windows using Visual Studio



> The internal threads of FIX Antenna were named firstly in FIX Antenna C++ v2.19.0 (r186).
>
> The ability to rename the threads in FIX Antenna was introduced as well.

Thread names in FIX Antenna C++

Add the threads' names to application logs' records.

The thread name can be settled by **'%thread_name'** argument in **Log.File.Format** property in the **engine.properties**, e.g:

```
Log.File.Format = %date{ISO8601} %timezone   %level%tablevel   [%logger]  %thread_name %thread %message
```

FIX Engine parameters#Log.File.Format

```
2019-08-16 12:35:53,663 UTC INFO [Engine] Worker_0 31940 -- "Session <MYAPP, CLIENT> : Asynchronously
connecting to 127.0.0.1:9106"
```

The List of FIX Antenna spawned threads

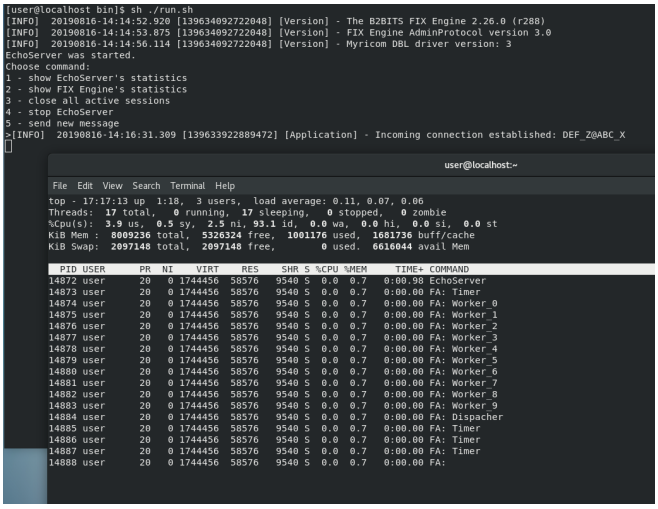
FIX Antenna adds 'FA: ' prefix to a thread name for Linux.

	Linux thread name	FIX Antenna thread name	Description
1	FA: Timer	Timer	Several timer threads which can be used for: • Internal scheduling events. Stop, Start, Reconnect a session • Scheduling for delayed message delivery. (non-public functionality). • Scheduled backup logs (non-public functionality). • Some internal health checks (non-public functionality) • Timer for connection timeout checks (non-public functionality) • Public health checks like control of used memory for windows. • Heartbeats timer.
2	FA: Worker_0 ... FA: Worker_N	Worker_0 ... Worker_N	Several threads. Session processing (receive/send) threads from thread pool used by EVEN and DIRECT_SEND modes and configuring by NumberOfWorkers parameter
3	FA: Dispacher	Dispacher	Thread that is listening and handling incoming and outgoing connections. Performs protection from abnormal behavior (DDOS protection)
4	FA: AbsolutTime	AbsolutTimer	Public timer scheduling tasks.
5	FA: ExlusiveRec	ExlusiveReceiveTaskDedicatedWorker	A dedicated thread for receiving in aggressive mode.
6	FA: NewInLinkTa	NewInLinkTask	Thread that accepts a new connection.
7	FA: ExlusiveSen	ExlusiveSendTaskDedicatedWorker	A dedicated thread to send in the aggressive mode if sending try in the current thread has failed.
8	FA: AsyncConnec	AsyncConnectTask	Asynchronous connection to the initiator.
9	FA: DBLDispache	DBLDispacher	Thread that is listening and handling incoming and outgoing connections for Myricom DBL network cards.
10	FA: LSCommunica	LSCommunicator_Impl	• Some internal utility threads.
11		<Unnamed threads>	• Some internal utility threads. • TCP logging thread (TCPAppender for log4cpp)

Using the top for viewing thread names

The threads names can be viewed using a command:

```
top -H
```



How to change the thread name via FIX Antenna API

The thread name can be changed with a function:

```
static void System::Thread::setName ( char const * name );
```