



LEAST COST ROUTING ENGINES

OUT-OF-THE-BOX MODULES OR MIXTURES

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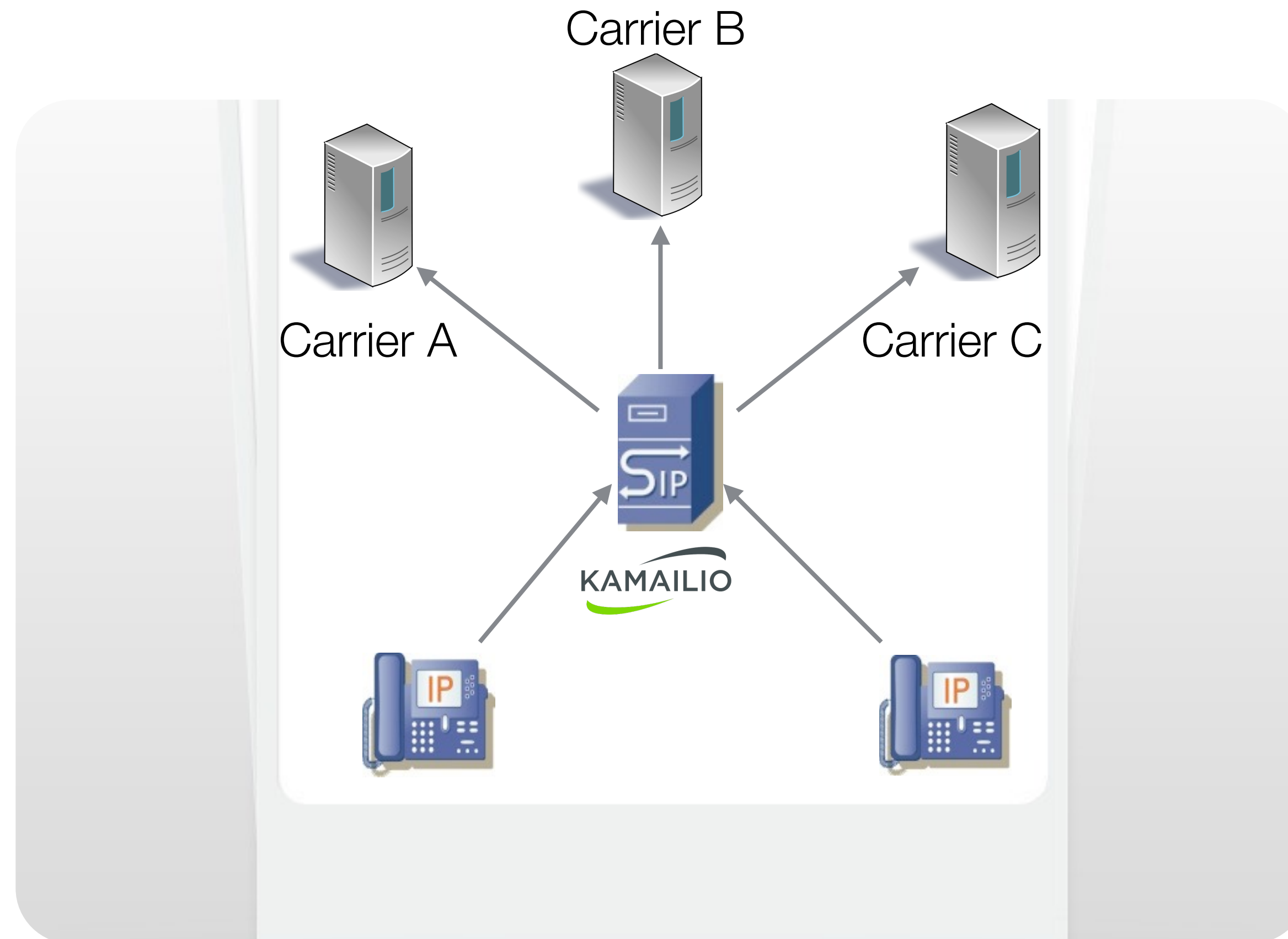


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- Least cost routing reasons
 - lower termination fees
 - quality of service
 - high availability (redundancy)



- Least cost routing metrics
 - cost
 - priority
 - time intervals
 - session type

Common LCR operations: strip prefix; add prefix; format caller id; add specific headers



LCR
OUT-OF-THE-BOX MODULES

LCR

■ LCR capabilities

- select destination gateways based on longest prefix, priority and distribution weight, with option for sequential forwarding of to one or more gateways
- match regexp on caller and callee addresses
- do strip or prefix operations over dialled number
- reload records at runtime upon a rpc command
- three database tables instead of two
 - lcr_rule - returns rule id based on prefix and pattern
 - lcr_rule_target - returns gw id based on rule id and priorities
 - lcr_gw - destination specific operations and attributes
- main function prototypes
 - **load_gw(id, ...)** takes lcr_id parameter (group identifier)
 - also can take target URI username and caller URI params
 - **next_gw()** takes no parameter - executed also after load_gw()

```
if (!load_gws("1")) {
    sl_send_reply("500", "Server Internal Error - Cannot load gateways");
    exit;
}

if (!load_gws("1", "$rU", "$ai")) {
    sl_send_reply("500", "Server Internal Error - Cannot load gateways");
    exit;
}

if (!next_gw()) {
    sl_send_reply("503", "Service not available - No gateways");
    exit;
}
```

LCR

```
mysql> select * from lcr_rule;
```

id	lcr_id	prefix	from_uri	request_uri	stopper	enabled
1	1	44	NULL	NULL	0	1
2	1	442	NULL	NULL	0	1
3	1	443	NULL	NULL	0	1
4	1	49	NULL	NULL	0	1
5	1	49800	sip:004930[1-9][0-9]+@	NULL	0	1
6	1	491	NULL	NULL	0	1

```
mysql> select * from lcr_rule_target;
```

id	lcr_id	rule_id	gw_id	priority	weight
1	1	1	1	10	1
2	1	2	2	10	1
3	1	3	2	10	1
4	1	4	2	10	1
5	1	5	1	10	1
6	1	5	3	20	1
7	1	6	1	10	1

```
mysql> select * from lcr_gw;
```

id	lcr_id	gw_name	ip_addr	hostname	port	params	uri_scheme
1	1	gw1	10.1.1.101	NULL	5060	NULL	1
2	1	gw2	10.1.1.102	gw.com	5070	NULL	1
3	1	gw3	10.1.1.103	NULL	5060	NULL	1

transport	strip	prefix	tag	flags	defunct
1	NULL	1234	NULL	1	NULL
1	0	NULL	NULL	1	NULL
1	NULL	NULL	abcd	1	NULL

LCR

```
loadmodule "lcr.so"

modparam("lcr", "db_url", DBURL)
modparam("lcr", "gw_uri_avp", "$avp(lcr_gw_uri)")
modparam("lcr", "ruri_user_avp", "$avp(lcr_ruri_user)")
modparam("lcr", "lcr_id_avp", "$avp(lcr_id)")
modparam("lcr", "flags_avp", "$avp(lcr_flag)")

route[LCR_ROUTE] {
    if (!is_method("INVITE")) {
        return;
    }
    # send to lcr only international numbers
    if (!$rU=~"^(\\+|00)[1-9][0-9]{3,20}$")
        return;
    if ($rU=~"^00") {
        strip(2);
    } else {
        strip(1);
    }
    if (!load_gws("1")) {
        send_reply("503", "Error loading gateways");
        exit;
    }
    ## - dumping the list of lcr gateways
    # $var(i) = 0;
    # while( $(avp(lcr_gw_uri)[$var(i)]) != $null) {
    #     xdbg("loaded gw_uri_avp[$var(i)]='$avp(lcr_gw_uri)[$var(i)]'\n");
    #     $var(i) = $var(i) + 1;
    # }
    # set for use the first matched gateway
    if (!next_gw()) {
        send_reply("503", "No available gateways");
        exit;
    }
    xdbg("first lcr route - ruri_user_avp=[$avp(lcr_ruri_user)]\n");
    route(LCR_RELAY);
    exit;
}
}
```

```
route[LCR_RELAY] {
    t_on_branch("MANAGE_BRANCH"); # - for nat traversal
    t_on_reply("MANAGE_REPLY"); # - for nat traversal
    t_on_failure("LCR_REROUTE"); # - for gw re-routing
    if (!t_relay()) {
        sl_reply_error();
    }
    exit;
}

failure_route[LCR_REROUTE] {
    route(NATMANAGE);
    if (t_is_canceled()) {
        exit;
    }
    if (!t_check_status("408|50[0-4]")) {
        # - let response go upstream
        exit;
    }
    # re-route to the next lcr gateway
    if (!next_gw()) {
        t_reply("503", "No more gateways");
        exit;
    }
    xdbg("nest lcr route - ruri_user_avp=[$avp(lcr_ruri_user)]\n");
    route(LCR_RELAY);
    exit;
}
```

- Carrier route capabilities

- Provides least cost routing, balancing and blacklisting
- Loads routing records from database or ini-like configuration file
- It can work in a single routing tree (e.g., for one carrier) or with multiple per user
- It uses route tree domain concept for fallback routing
- Designed to work with large number of subscribers (e.g., millions) and routing records (e.g., hundred thousands)
- Reload routing records at runtime upon a rpc command

```
request_route {
    # route calls based on hash over callid
    # choose route domain 0 of the default carrier

    if(!cr_route("default", "0", "$rU", "$rU", "call_id")){
        sl_send_reply("403", "Not allowed");
    } else {
        # in case of failure, re-route the request
        t_on_failure("RETRY");
        # relay the request to the gateway
        t_relay();
    }
}
```

```
failure_route[RETRY] {
    revert_uri();
    # in case of failure, send it to an alternative route:
    if (t_check_status("408|5[0-9][0-9]")) {
        # choose route domain 1 of the default carrier
        if(!cr_route("default", "1", "$rU", "$rU", "call_id")){
            t_reply("403", "Not allowed");
        } else {
            t_relay();
        }
    }
}
```

CARRIERROUTE

DROUTING

- Drouting capabilities
 - Provides least cost routing and round-robin or random balancing
 - Loads routing records from database and can reload them at runtime upon a rpc command
 - Rules can be grouped per user
 - Can execute a config route block
 - Can route based on the time-of-the-day rules
 - Can do strip or prefix operations

```
request_route {  
    ...  
    if(do_routing("1")) {  
        t_on_failure("RETRY");  
        t_relay();  
    }  
}
```

```
failure_route[RETRY] {  
    ...  
    if(next_routing()) {  
        t_on_failure("RETRY");  
        t_relay();  
    }  
}
```



LCR
BASIC MODULES

■ pdt - prefix-domain translation

- indexing database records in a tree in memory
 - *relation between:*
 - *source domain*
 - *prefix*
 - *domain*
- result:
 - *domain part of R-URI is updated*
- can also
 - *remove the prefix from R-URI username*
- support to reload records at runtime upon a rpc command

```
if(pd_translate("$fd", "2")) {  
    t_relay();  
    exit;  
}
```

```
prefix=123 - source domain(FROM)=kamailio.org
```

```
entry in database:
```

```
sdomain=kamailio.org  
domain[123]=alpha.org  
domain[124]=beta.org  
domain[125]=gamma.org
```

```
The RURI will be updated in the following way:
```

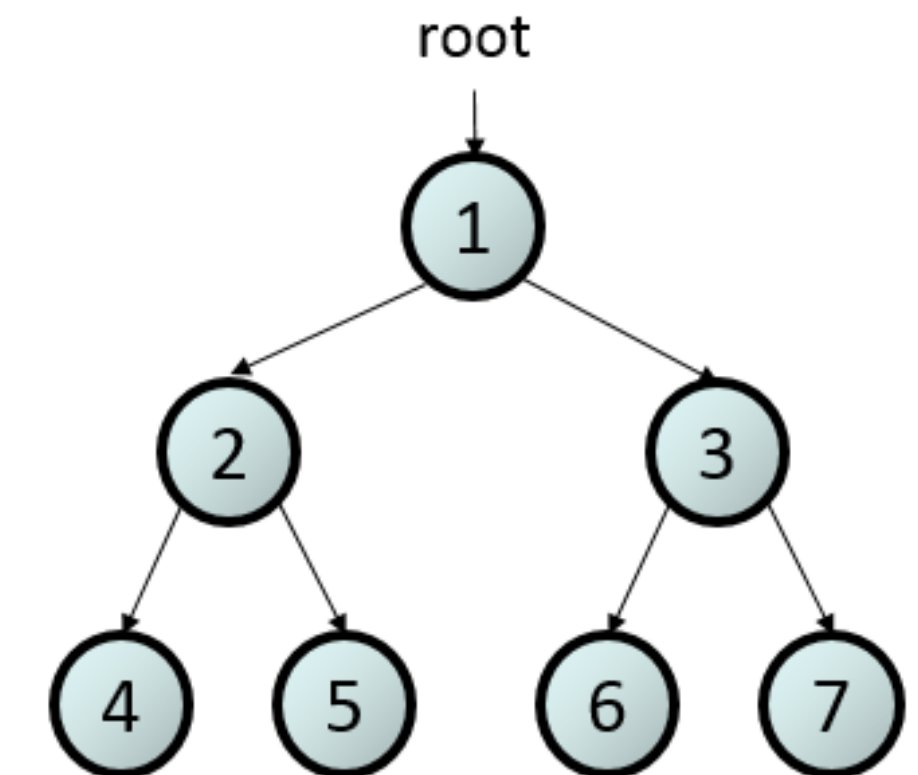
```
sip:12391001@kamailio.org => sip:91001@alpha.org
```

PDT

MTREE

■ in-memory tree-indexed caching system - readonly - full db reload

- can load many trees in memory
 - **relation between:**
 - *digit-based key - number, prefix, DID*
 - *value*
- result:
 - **a script variable is filled with 'value'**
- the value is a string
 - **but can be further processed with script operations**
 - *so you can store like list of params, comma separated values, etc.*



```
modparam("mtree", "pv_value", "$var(mtval)")
```

```
request_route {
```

```
...
```

```
# match the prefix
```

```
if(!mt_match("srt", "$rU", "0")) {  
    send_reply("404", "No prefix route");  
    exit;  
}
```

```
$ru = $var(mtval);
```

```
t_relay();
```

```
}
```

id	tprefix	tvalue
1	+4930	sip:1.2.3.4
1	+44	sip:2.3.4.5

■ Dialplan translation

- perl-like regular expression matching and substitutions
 - requires libpcre
- hash table in memory
 - **relation between:**
 - *dialplan id*
 - *priority*
 - *match operator - regexp, equal, fast match*
 - *matching expression*
 - *matching length*
 - *substitution regular expression*
 - *replacement expression (with support for back references and config variables)*
 - *attributes*
- result:
 - **output variable may be update based on replacement expression**
 - **attributes returned in a local variable**

id	dp_id	pr	match_op	match_exp	match_len	subst_exp	repl_exp	attrs
1	1	1	1	^0049	0			2
1	1	1	1	^030	0	^0(.+)\$	0049\1	2
1	1	1	1	^sip:0044[1-4][0-9]+@.+	0	^(.+)\$	\1@2.3.4.5	2

```
dp_replace("1", "$ru", "$ru");
```

DIALPLAN

PREFIX_ROUTE

- **prefix-route** - execute config route blocks based on prefix
- prefix based selection of config routing blocks
 - database backend (db api v2 !)
 - cached records in memory
 - reload of records upon a rpc command

```
request_route {  
    ...  
    if(prefix_route()) exit;  
    ...  
}  
  
route[SE] {  
    prefix("123*");  
    $rd="sweden.gateway.com";  
    t_relay();  
    exit;  
}
```

prefix	route	comment
46	SE	Sweden
47	NO	Norway
479	NOMOB	Norway mobile
49	DE	Deutschland
39	IT	Italy



LCR
BASIC MODULES

```

loadmodule "mtree.so"

# -- mtree params --
modparam("mtree", "db_url", "mysql://kamailio:kamailiorw@localhost/kamailio")
modparam("mtree", "mtree", "name=srt;dbtable=siproutes;type=0")
modparam("mtree", "char_list", "0123456789*+")
modparam("mtree", "pv_value", "$var(mtval)")

request_route {
...
# match the prefix
if(!mt_match("srt", "$rU", "0")) {
    send_reply("404", "No prefix route");
    exit;
}

# round robin dispatching
$var(dsid) = $(var(mtval){s.int});
if(!ds_select_dst("$var(dsid)", "4")) {
    send_reply("404", "No destination");
    exit;
}
...
}

```

```

+-----+-----+-----+
| id | tprefix | tvalue |
+-----+-----+-----+
| 1 | +4930 | 2 |
+-----+-----+-----+

```

MTREE
+
DISPATCHER

```

# setid      destination      flags      priority      attributes
# (int)      (sip uri)           (int,opt)  (int,opt)     (str,opt)

# proxies
2      sip:127.0.0.1:5080;transport=tcp  0      10      class=4;prefix=448;strip=2;pipe=p10
2      sip:127.0.0.1:5082;px=vx        0      5       duid=abc;socket=udp:192.168.0.125:5060

```


DIALPLAN + DISPATCHER

```
loadmodule "dialplan.so"

# -- dialplan params --
modparam("dialplan", "db_url", "mysql://kamailio:kamailiorw@localhost/kamailio")
modparam("dialplan", "attrs_pvar", "$var(attrs)")

request_route {
    ...
    # match and translate
    $var(attrs) = "2"; # init with default dispatcher list id, in case of no match
    dp_match("1", "$rU");

    # round robin dispatching
    $var(dsid) = $(var(attrs){s.int});
    if(!ds_select_dst("$var(dsid)", "4")) {
        send_reply("404", "No destination");
        exit;
    }
    ...
}
```

```
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| id | dp_id | pr | match_op | match_exp | match_len | subst_exp | repl_exp | attrs |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| 1 | 1 | 1 | 1 | ^0049 | 0 | | | 2 |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+

```

```
# setid destination flags priority attributes
# (int) (sip uri) (int,opt) (int,opt) (str,opt)

# proxies
2 sip:127.0.0.1:5080;transport=tcp 0 10 class=4;prefix=448;strip=2;pipe=p10
2 sip:127.0.0.1:5082;px=vx 0 5 duid=abc;socket=udp:192.168.0.125:5060
```

```

request_route {
  ...
  # match the prefix
  if(!mt_match("srt", "$rU", "0")) {
    send_reply("404", "No prefix route");
    exit;
  }

  if($(var(mtval){param.value,hdr}) == "pai") {
    append_hf("P-Asserted-Identity: ...\r\n");
  } else {
    append_hf("Remote-Party-Id: ...\r\n");
  }

  # round robin dispatching
  $var(dsid) = $(var(mtval){param.value,dsid}{s.int});
  if(!ds_select_dst("$var(dsid)", "4")) {
    send_reply("404", "No destination");
    exit;
  }
  ...
}

```

params string
json
Xml

id	tprefix	tvalue
1	+4930	dsid=2;hdr=pai;nr=e164;

MTREE
+
DISPATCHER
+
EXTRAS



THANK YOU!

SEE YOU AT THE NEXT KAMAILIO WORLD CONFERENCE!

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